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SCIENCE

[REVISED]

8

EIGHTH STANDARD

PART - 2

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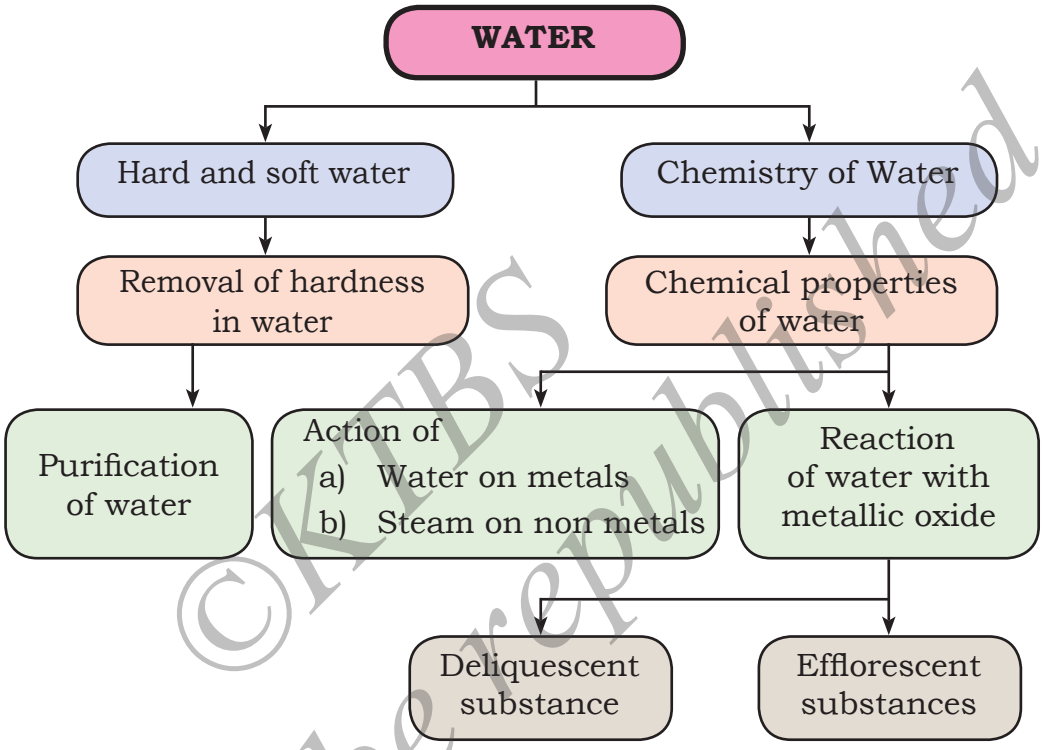
Part 2 - Index

CHAPTER 13

WATER



You know that water is one of the most abundant and important compounds in the world. It is the major constituent of all living organisms. All plants contain water. The human body has about 65% of water. Neither plants nor animals can survive without water.

Recall: The biological significance of water. Holy water, Ab-e-zam-zam, Gangajal are traditionally used words in different cultures. Rivers are respected. These have inherent biological significance and depict water as a precious commodity.

Water is made up of elements hydrogen and oxygen. One molecule of water contains two atoms of hydrogen and one atom of oxygen which are chemically combined.

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$$

From time immemorial, water has been the driving force of every civilization and people attached great importance to an adequate supply

of water for different purposes like agriculture, cooking, drinking, washing and industrial purposes.

In ayurveda water has been given an important place. Water is also used to treat common health problems. It is called hydrotherapy.

Purification of water

Traditional methods of obtaining potable water include the following. boiling, exposing it to sunlight , adding Tulasi leaves, adding camphor, dropping red hot iron balls.

There are different methods for removal of colour, odour, suspended matter and microbes from water. In addition there are many methods for removal of hardness. Water treatment includes stages of coagulation or sedimentation, filtration, decolourisation, deodourization and sterilisation. Alum is used for sedimentation. Some of these practices have been used in ancient civilization also.

Think : Why is ceramic filter candle used in water purification equipment?

Water is a very good fire extinguisher. Though it contains combustible hydrogen and oxygen which is a supporter of combustion, *water is neither a supporter of combustion nor a combustible substance.*

Think : Why does hydrogen lose its combustibility after it combines with oxygen? Why does oxygen lose its ability to support burning?

The burning of hydrogen is the reaction of combustion of hydrogen with oxygen.

Know this : Fish living in water absorb dissolved oxygen for respiration, not oxygen from the compound 'water'.

You have studied physical properties of water in the previous classes. Now let us learn more about the chemical properties of water.

Chemical Properties Of Water

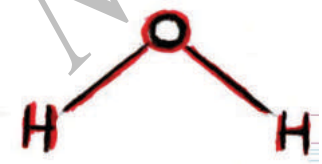


Fig. 13.1 Structure of water molecule

You know that chemical formula of water is H_2O. In a water molecule one atom of oxygen is bound to two atoms of hydrogen. as shown in figure 13.1.

Water is called **"universal solvent"** because it dissolves more substances than any other solvent.

Find Out : Sea water is salty. Why?

Activity : 13.1

Dip a piece of blue or red litmus paper in pure water. What inference do you draw from this activity?

Action of water on metals

We store water in different metallic containers. We also boil water in metallic containers. Does water react with any metallic container?

Metals like copper, aluminium and tin show no reaction with water at ordinary temperature.

Many metals and their alloys are used to prepare utensils, buckets, kitchenware and other articles, because they do not react with water under normal conditions.

Sodium and potassium are soft metals and can be cut with a knife. They react with water, forming their respective hydroxides liberating hydrogen gas, hence they are kept in kerosene.

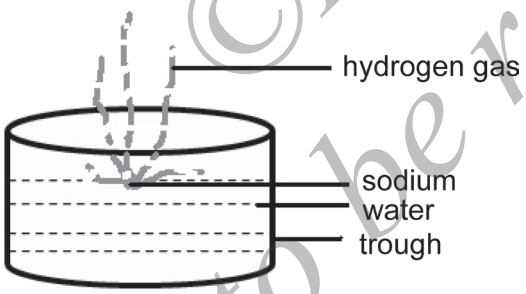


Fig. 13.2

Activity 13.2

Take a clean piece of sodium. Dry it using blotting paper. Cut a small piece of it about the size of a green gram dhal. Drop it carefully into water taken in a beaker. Notice that the sodium piece moves randomly on the surface reacting with water violently. It gradually diminishes in size and finally disappears. It reacts with water forming sodium hydroxide and hydrogen .Test the resulting liquid in the beaker with blue and red litmus papers. The solution is basic.

Note : Sodium is to be kept in kerosene as it can react with oxygen and water vapour present in air. The metal should always be handled with a pair of tongs because it can react even with moisture on the hand and cause blisters. Kerosene has no affinity towards sodium.

Metals like sodium and potassium react with cold water forming respective hydroxides liberating Hydrogen gas.

$$\underset{\text{(Sodium)}}{2Na} + \underset{\text{(water)}}{2H_2O} \rightarrow \underset{\text{(Sodium Hydroxide)}}{2NaOH} + \underset{\text{(Hydrogen)}}{H_2}\uparrow$$

Activity : 13.3

Write the equation for the reaction between potassium and water.

Recall : Metals like iron form rust. The process of rusting will be quick during rainy season. Rust is hydrated oxide of iron. How can this be prevented?

Other metals also react with water at different conditions.

$$\underset{\text{(Calcium)}}{Ca} + \underset{\text{(Steam)}}{2H_2O} \xrightarrow[\text{(Room temperature)}]{} \underset{\text{(calcium hydroxide)}}{Ca(OH)_2} + \underset{\text{(hydrogen)}}{H_2\uparrow}$$

$$\underset{\text{(magnesium)}}{Mg} + \underset{\text{(boiling water)}}{2H_2O} \rightarrow \underset{\text{(Magnesium hydroxide)}}{Mg(OH)_2} + \underset{\text{(Hydrogen)}}{H_2\uparrow}$$

When steam is passed over red hot metals like zinc, iron, magnesium we get respective oxides and hydrogen gas.

$$\underset{\text{(Zinc)}}{Zn} + \underset{\text{(Steam)}}{H_2O} \rightarrow \underset{\text{(zinc oxide)}}{ZnO} + \underset{\text{(hydrogen)}}{H_2\uparrow}$$

$$\underset{\text{(Iron)}}{3Fe} + \underset{\text{(Steam)}}{4\,H_2O} \rightarrow \underset{\text{(Magnetic iron oxide)}}{Fe_3O_4} + \underset{\text{(hydrogen)}}{4H_2\uparrow}$$

$$\underset{\text{(magnesium)}}{Mg} + \underset{\text{(Steam)}}{H_2O} \rightarrow \underset{\text{(magnesium oxide)}}{MgO} + \underset{\text{(hydrogen)}}{H_2\uparrow}$$

Action of steam on non-metals:

1. When steam is passed over redhot coke, a mixture of carbon monoxide and hydrogen is formed.

$$\underset{\text{(carbon)}}{C} + \underset{\text{(steam)}}{H_2O} \xrightarrow{\text{heat}} \underset{\text{(carbon monoxide)}}{CO\uparrow} + \underset{\text{(Hydrogen)}}{H_2\uparrow}$$

The mixture of carbon monoxide and hydrogen in a ratio of 1:2 is called water gas.

Uses of water gas

- Used as an industrial fuel.
- Used in the manufacture of hydrogen (Bosch process)

2. When steam is passed over red hot silicon, which is a non metal, silicon dioxide and hydrogen gas are formed.

$$\underset{\text{(Silicon)}}{Si} + \underset{\text{(Steam)}}{2H_2O} \rightarrow \underset{\text{(Silicon dioxide)}}{SiO_2} + \underset{\text{(hydrogen)}}{2H_2\uparrow}$$

Reaction of water with non metallic oxides

Generally when a non metallic oxide dissolves in water, acid is formed.

$$\underset{\text{(Carbon dioxide)}}{CO_2} + \underset{\text{(Water)}}{H_2O} \rightarrow \underset{\text{(Carbonic acid)}}{H_2CO_3}$$

Carbonic acid is present in soft drinks.

Acid rain

When nitrogen dioxide, carbon dioxide and sulphur dioxide present in the atmosphere of certain industrial areas, dissolve in rain water, they cause acid rain.

$$\underset{\text{(Sulphur dioxide)}}{SO_2} + \underset{\text{(water)}}{H_2O} \rightarrow \underset{\text{(sulfurous acid)}}{H_2SO_3}$$

$$\underset{\text{(Nitrogen dioxide)}}{3NO_2} + \underset{\text{(Water)}}{H_2O} \rightarrow \underset{\text{(Nitric acid)}}{2HNO_3} + \underset{\text{(Nitric oxide)}}{NO}$$

And

$$\underset{\text{(Carbon dioxide)}}{CO_2} + \underset{\text{(Water)}}{H_2O} \rightarrow \underset{\text{(Carbonic acid)}}{H_2CO_3}$$

Find out : Mathura oil refinery is situated very close to Taj Mahal. The supreme court issued an order to shift it to a distant place. Why?

Reaction of water with metallic oxides

When calcium oxide reacts with water it forms calcium hydroxide.

$$\underset{\text{(Calcimum oxide)}}{CaO} + \underset{\text{(Water)}}{H_2O} \rightarrow \underset{\text{(Calcium hydroxide)}}{Ca(OH)_2}$$

You might have seen this reaction when a paste for white washing is being prepared.

Generally metallic oxides are basic.

Deliquescent Substances

You might have seen jaggery becoming moist when exposed to air for some time. Like jaggery there are many substances such as magnesium chloride, solid sodium hydroxide, solid potassium hydroxide, anhydrous calcium chloride, calcium nitrate and ferric chloride wich absorb moisture.

Activity 13.4

Take a dish and put some sodium nitrate and keep it exposed to air for 5-10 minutes. Observe the changes, Write your observations. Sodium nitrate becomes wet.Potassium nitrate does not become wet when exposed to air. Can you give reason for this?

Definition

Certain water-soluble substances when exposed to the atmosphere at ordinary temperature, absorb moisture from the atmospheric air to become moist and ultimately dissolve in the absorbed water. Such substances are called *deliquescent* substances and the phenomenon is called **deliquescence**.

Try the above activity using caustic soda (NaOH) or anhydrous calcium chloride or with some chemical fertilizers. Write your observation.

Think : Deliquescence is more common in coastal area. Why?

Know this : Compounds that remove water from the surrounding air are called *'desiccants'* or drying agents. Concentrated sulphuric acid and calcium chloride monohydrate are examples for desiccants. We often find small packs of solid desiccants placed inside electronic equipment or in medicine tablet bottles.

Efflorescent substances

Certain hydrates lose water when exposed to air for example sodium sulphate ($Na_2SO_4.10H_2O$), which loses its water content and become powder. The loss of water from hydrated compounds to the surroundings is called efflorescence. Commonly used substance, washing soda is another example for an efflorescent substance.

Hard water

Water is a very common and suitable solvent. Some impurities dissolve in it very easily. Mostly soluble salts of calcium and magnesium make water hard. As the percentage of these salts increases in water, the degree of hardness also increases.

Hard water does not produce much lather with soap. Generally water from areas having limestone and other mineral rocks is hard water. Calcium and magnesium bicarbonates, sulphates and chlorides in general cause hardness in water.

The salts causing hardness are water soluble. Calcium carbonate does not cause hardness because it is insoluble in water.

Soft water

Soft water produces a rich lather with soap. Rain water and spring water are examples of soft water since they contain very small amount of dissolved salts in them.

Think : Why is hard water not used in industrial boilers?

Hard water contains calcium and magnesium salts. If it is used in industrial boilers, it forms insoluble salts of calcium and magnesium. They produce scale on the inner walls of the boilers, which reduces heating efficiency. There are chances of explosion of the boilers. Also they cause corrosion of the boiler.

Soap is not effective in hard water.

Methods of Removal of Hardness of Water

Hardness of water can be removed by two methods: -

- If hard water contains calcium and magnesium bicarbonates, it can be made soft by boiling.

  In this reaction, calcium bicarbonate decomposes to insoluble calcium carbonate and carbon dioxide.

  Example : $Ca(HCO_3)_2 \xrightarrow{heat} CaCO_3\downarrow + H_2O + CO_2\uparrow$

  (calcium bicarbonate) (calcium carbonate) (water) (carbon di oxide)

- Hardness can be removed by the addition of washing soda (Na_2CO_3) to water. In this reaction, the soluble salts of calcium and magnesium are converted into insoluble carbonates. The soluble sodium salts do not cause hardness.

Recall : Your knowledge of chemical double decomposition or exchange

Examples :

$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$

(Calcium cloride) (Sodium Carbonate) (Calcium Carbonate) (Sodium Chloride)

$Ca(HCO_3)_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaHCO_3$

(Calcium bicarbonate) (Sodium Carbonate) (Calcium Carbonate) (Sodiumbicarbonate)

$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3\downarrow + Na_2SO_4$

(Calcium Sulphate) (Sodium Carbonate) (Calcium Carbonate) (Sodium sulphate)

Activity 13.5

Write the equation of softening of hard water containing magnesium salts with sodium carbonate.

Activity 13.6

Experiment to show the removal of hardness of water by washing soda

Materials required :

1. beaker 2. glass rod 3. washing soda (sodium carbonate) 4. hard water

Take some hard water in a beaker and add a small quantity of washing soda to it. Stir it with a glass rod. Allow the insoluble carbonates to settle down as precipitate. Filter or decant the liquid.

Water, so obtained is soft. But it is unfit for drinking as it contains excess of washing soda and excess of sodium salts.

Desalinisation plant : Desalinisation is an artificial process by which saline water (generally sea water) is converted into fresh water. It is suitable for human consumption. Sometimes the process produces table salt as a by-product. This method was invented during second world war.

Activity 13.7

Behaviour of soap with hard water and soft water

Materials required: Hard water, 1 g of soap (from any transparent soap), 200 mL warm distilled water, 0.5 g of Epsom salt ($MgSO_4.7H_2O$) washing soda (Na_2CO_3)

Procedure:

1. Make a soap solution by dissolving about 1 g of soap in 100 ml of warm distilled water. Allow the solution to cool.
2. Prepare a solution of hard water by dissolving about 0.5 g of Epsom salt in 100 ml of distilled water.
3. In a test tube, take a small quantity of hard water and add the soap solution to it drop by drop. Stir it well. What do you observe?

   You may observe very little lather being formed.
4. In another test tube, take the same quantity of the hard water and add a pinch of washing soda and shake vigorously. Allow the precipitate to settle. To this, add the soap solution drop-by-drop and stir it well. What do you observe?

You will find that a large amount of lather is formed.

Depending on the exact concentration of your solutions, you will find that after the addition of washing soda, lather is formed relatively easily. Washing soda softens the hard water.

All salty water is not hard water. Try activity 13.7 with a solution of sodium chloride solution. You will come to know that sodium salts do not cause hardness.

You have learnt

- Chemical properties of water.
- Action of water on metals.
- Action of steam on non metals.
- Reaction of water with metallic oxide.
- Deliquescent and Efflorescent substances.
- Hard and soft water
- Removal of hardness in water

EXERCISES

I. Four alternatives are given to each of the following incomplete statements/questions. Choose the right answer:

1. Magnesium sulphate crystals are commonly called.
   a. gypsum salt b. epsom salt c. green vitriol d. alum.
2. When you buy washing soda from the market, you will get it in powder form because
   a. the crystals of washing soda quickly lose water molecules
   b. the shop keeper prefers to powder the crystals.
   c. washing soda does not form crystals.
   d. washing soda is a drying agent.
3. A sample of hard water is heated in a utensil. A white deposit of calcium carbonate is formed. This is due to the presence of
   a. calcium chloride b. magnesium sulphate
   c. calcium bicarbonate d. calcium hydroxide
4. The salt that causes hardness in water and also liberates carbon dioxide on heating is,
   a. magnesium bicarbonate b. calcium chloride
   c. magnesium sulphate d. calcium sulphate.

5. When steam is passed over red hot iron we get the following products.

   a. ferric hydroxide and hydrogen

   b. magnetic iron oxide and hydrogen

   c. ferrous hydroxide and hydrogen

   d. ferrous oxide and hydrogen

II. Fill in the Blanks with suitable words

1. Chemical name of Epsom salt is _____.
2. The chemical used to soften hard water is _____.

III. Match the following

A	B
1. causes scale	a. calcium oxide
2. basic oxide	b. soap
3. test for hardness of water	c. sulphur dioxide
4. acidic oxide	d. calcium bicarbonate
	e. neutral oxide
	f. does not react with water

IV. Answer the following :

1. Water is tasteless, but we experience different tastes of water in different places. Why?
2. Write balanced equations for the reaction of sodium, potassium and calcium in cold water.
3. What happens when steam is passed over red hot iron? Write the equation.
4. Define the terms efflorescence and deliquescence.
5. Give two reasons to prove that water is a compound and not an element.
6. Name three metals which do not react with water, under normal conditions.
7. Name the products formed when the following oxides are dissolved in water. Write balanced equation.

   a. Sulphur dioxide

   b. Potassium oxide

   c. Carbon dioxide

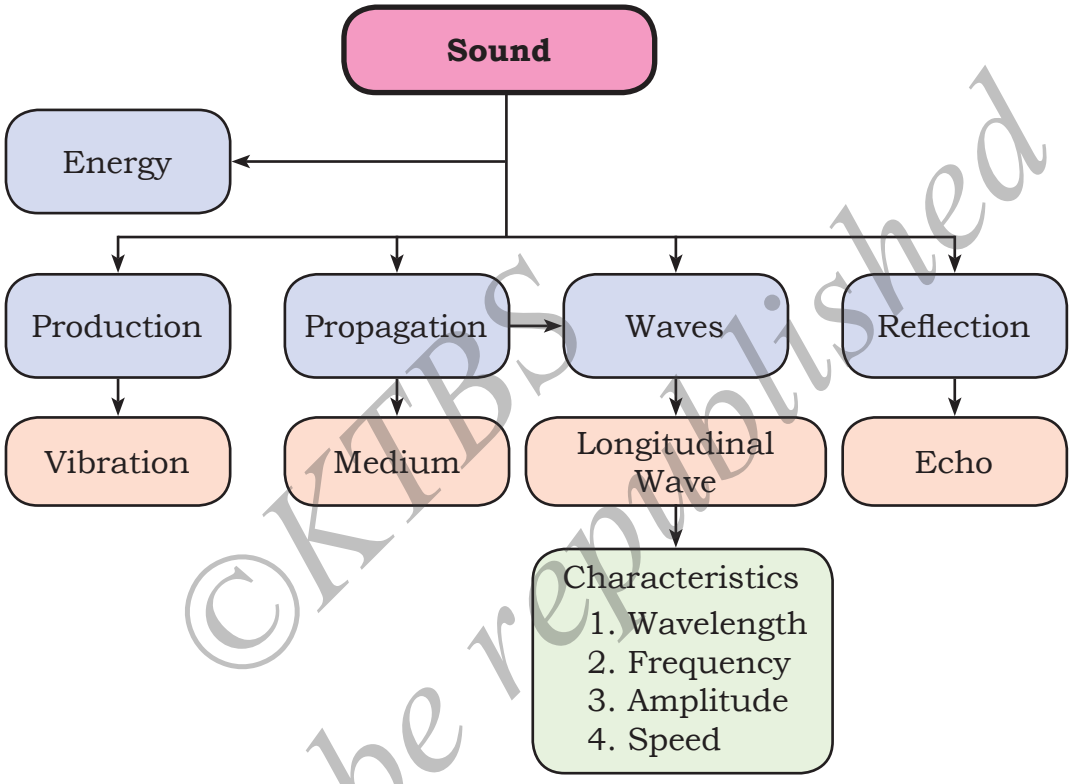
   d. Calcium oxide
8. State the reasons for hardeness in water.

V. Give reasons for the following :

1. Sodium metal should be stored in kerosene.
2. Washing soda loses its crystalline structure quickly.
3. When calcium nitrate crystals are exposed to air, a solution is formed.

CHAPTER 14

WORLD OF SOUNDS



What is sound? We can say that sound is a physical sensation felt by our ears.

Think : There are many sounds which we normally do not hear. For example, sounds of heartbeat. Do you know what the doctors do to hear those soft sounds?

Activity 14.1

Take a thin strip of paper. Hold it near a loud speaker. Do you see any movement in the paper? What inference can you draw about sound from this activity?

Activity 14.2

Fig. 14.1 A person using a microphone

If sound is a form of energy, it should be possible for us to convert it into other forms of energy. It should also be possible to convert other forms of energy into sound. Think of such situations in daily life. Have you seen a microphone? Figure 14.1 shows a common type of microphone. We speak into a microphone while addressing a large gathering. You feed energy into the microphone in the form of sound. What does a microphone do? What happens to the sound inside a microphone? What happens in a loudspeaker? Do you know another device that transforms energy involving sound?

What conclusions can you draw from activity 14.2 ?

Sound helps animals to find their food and escape from enemies

Sound can be a signal of alarm or danger. Sound may be a reminder of something we need to do. It may be a way of drawing attention, an expression of an idea or emotion. It can help to grasp ideas. List a few instances about functions of sound from your daily experience. Think of other purposes served by sound.

Sound as a form of energy: You have learnt in your earlier classes that sound is a form of energy. When do we say that something like light or sound is a form of energy? You may recall that energy is the ability to do work. Can sound do work? If it can, then, we may say that sound is a form of energy. Let us do some activities to see whether or not sound can do work.

No horn

Know this : Sound can disturb others. Have you seen sign boards like the one shown in the figure? Where do they display such boards and why?

Production of sound: Do you know how we produce sound when we talk, whistle or sing? How does a bell produce sound? What causes the sound of a thunder? Let us investigate.

Activity 14.3

Sit comfortably in a chair. Place one of your hands firmly midway on the throat. Say 'ahhhh....!' as long as you can. Do you sense anything at the fingertips? How does it feel to the hand while you produce the sound? Now change the kind of sound you produce. Instead of 'ahhhh...' you may now say 'Uhhhhh....'. Make different kinds of sounds-loud, faint, shrill and soft. Feel the changes in the region of the throat. Did you notice any movement inside?

Activity 14.4

We have observed people play on instruments like veena, guitar, sitar and violin. Make a list of musical instruments you know. Collect pictures of these instruments. Find out how each one of these produces sound. Record your observations in a suitable table.

Activity 14.5

Some of you may have music systems with box speakers at home. Take some ragi or mustard grains in a plate and place it on top of the speaker. Turn the music system on and observe the grains. What happens? Why did it happen? Steadily increase the volume and note the changes. What conclusions did you come to? Repeat this activity by placing the grains on a vibrating drum.

Activity 14.6

Take a rubber string. Stretch it tightly between two supports. Pluck the string. The string begins to vibrate. Note whether you can hear some sound. Stop the movement of the string. Did the sound also stop? Repeat this activity. Try the activity with a metal wire. What inference can you draw from this?

Activity 14.7

Start blowing air into a balloon. The balloon becomes bigger and bigger as in figure 14.2. Continue to blow until the balloon bursts. You suddenly hear a loud sound. From where did this sound come?

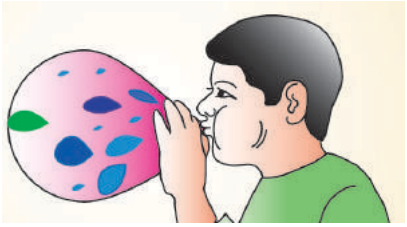


Fig. 14.2 Boy blowing a balloon

When do materials produce sound? As you know, materials generally produce sound when they move back and forth rapidly. We call such a motion as 'vibration'. Therefore, we may say that sound is produced when objects vibrate. There can be no sound without vibration. Think of some more activities to show that vibrating objects produce sound. You may note here that sound is produced when there is sudden expansion or compression of gases. For instance, the bursting of a balloon makes a loud sound. Think of other situations where sudden expansion of air or any gas produces sound.

Now let us understand how we produce sound when we speak or sing. We have a special apparatus called 'voice box'. 'Larynx' is the other name for voice box. This system helps us to produce sound.

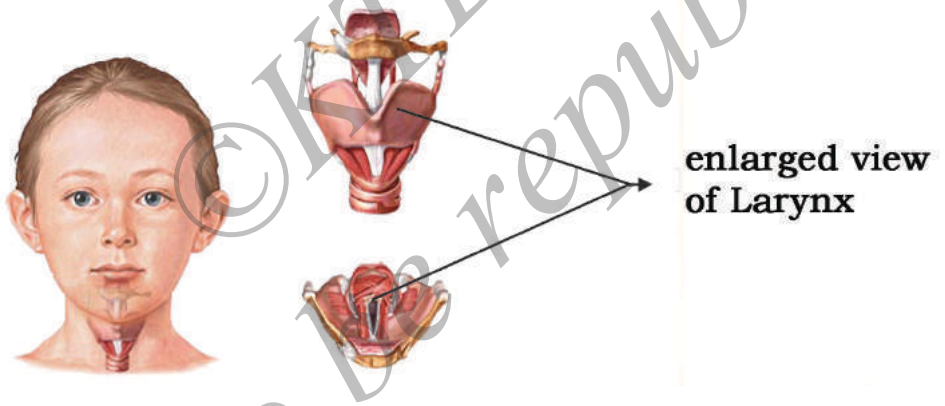


Fig. 14.3 Position of Larynx

Voice box is located at the upper end of the windpipe. There are two membranes in the voice box. These membranes are called vocal cords. They stretch across the voice box. The stretching leaves a small gap between membranes in the form of a narrow slit. The slit controls the passage of air. When we wish to produce sound, we push air through the slit. This causes the vocal cords to vibrate. The vibrations of the vocal cords produce sound. The muscles attached to the vocal cords help to loosen or tighten the vocal cords. This enables us to produce sounds of various qualities. The actual mechanism is more complicated than this.

Find out : You might have noticed the change in voice during cough and cold. Why?

How does the sound reach us from the source?

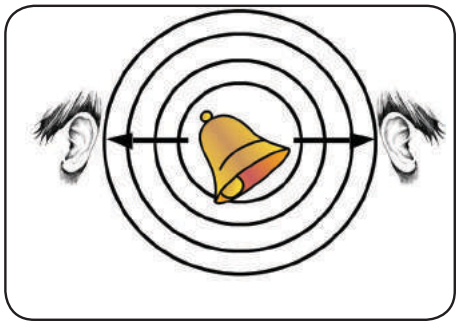


Fig. 14.4 Propagation of sound

How does sound travel from the source towards our ears? To understand this, let us recall an experience familiar to all. Let us imagine that we have thrown a stone into a pool of still water. Circular waves spread rapidly over water and they travel in all directions. Do water particles travel away from the point of disturbance? You can check by placing some sawdust over the surface. They do not travel away. Instead, they merely move up and down in their own position. Sound travels similarly in the form of waves. See figure 14.4. However, the vibration of particles of the medium will be in the direction of the sound wave itself.

Nature of sound: We have learnt that vibrations can produce sound. Therefore, sound is a kind of mechanical energy. What moves when sound travels through a medium such as air ? Energy moves through a medium by creating a disturbance in it. These disturbances may repeat themselves at regular intervals. Such periodic disturbances constitute a pattern. We call this pattern of disturbance as **wave.** Sound also travels through a medium in the form of waves. What is the nature of sound waves? Let us do an activity to understand this.

Activity 14.8

You might have played with a toy spring. We call it 'slinky'. Fix one end of a slinky firmly to a support on a table or floor. Hold the other end in your hand. Now, give pushes to the slinky back and forth along its length. Observe the pattern in the slinky. Refer figure 14.5 to get an idea of the pattern you see in the slinky. You observe, in some places of the slinky, the rings coming closer. We call this as ***compression.***

Between two compressions, you also see the rings moving apart. We call this ***rarefaction.*** *You observe alternate compressions and rarefactions all along the slinky. Observe the movement of the compressions and rarefactions. It appears as though the compressions and rarefactions are moving away towards the other end. Is it really so?*

Check by tying a thread to one of the rings. Is the thread moving towards the other end? Then what is moving here?

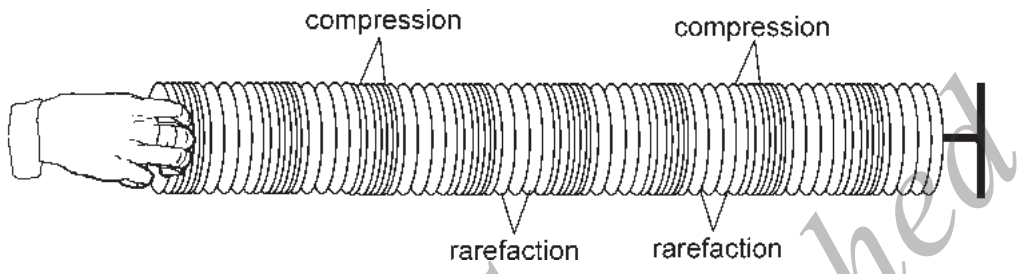


Fig 14.5 Alternate compressions and rarefactions all along the slinky

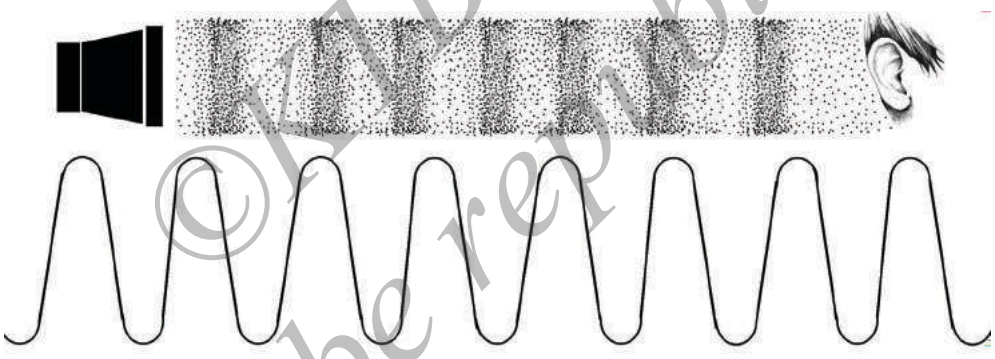


Fig 14.6 Propagation of sound through air and graphical representaion of a sound wave

Observe the slinky again. The thread tied to one of the rings moves back and forth along the length. Any motion of this type is longitudinal motion. A wave caused by such motion of particles is a longitudinal wave. Let us now return to sound waves.

Imagine that you are listening to music from a speaker. The sound from the speaker transmits energy to the surrounding medium. The surrounding medium here is air. The energy causes the air particles to compress. The compressed particles transmit their energy to the next neighbouring particles. The process continues. Thus, there will be several compressions and rarefactions in air before these vibrations reach your ear. Observe figure 14.6 to get an idea as to how this happens. You may note here again that the vibration of particles is parallel to the direction

of sound. From this, we may conclude that sound is also a longitudinal wave. Sound is a mechanical wave as it involves vibration of particles. Fig. 14.6 shows the typical way of representing a wave.

We just learnt that when sound travels, the particles of the medium vibrate. What happens when there is no medium at all? Can sound travel in the absence of a medium? Let us explore this through an activity.

Know this : There are transverse waves also. In this type of waves the particles of the medium vibrate perpendicularly to the line of propagation. Example : water waves. You will study more about such waves in higher classes.

Activity 14.9

Suspend a mobile phone inside an airtight glass bell jar as shown in figure 14.7. Connect the bell jar to a vacuum pump. When you call the phone number you can hear the ring tone. Now remove the air from the bell jar by using the pump. Observe the phone and the changes in the sound. What happens to the strength of sound? Why cannot you hear the sound after some time? What conclusion can you draw from this experiment?

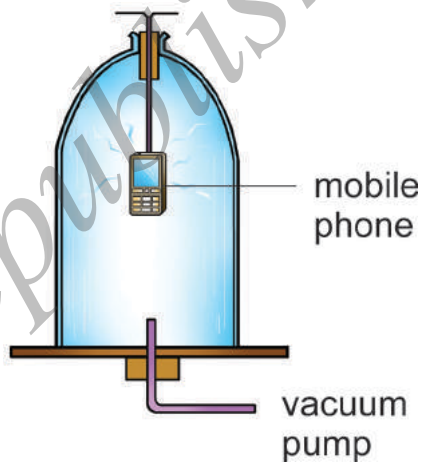


Fig.14.7 Experiment to show that sound cannot travel in vacuum

We have learnt that sound travels through gases. Can sound travel through solids and liquids too? In which of these media does the sound travel better? Let us investigate.

Activity 14.10

Place your ears firmly on a wooden table. Ask a friend to scratch the table at the other end. Did you hear the scratching? Raise your head so that the ear is about 10 cm above the table. Now ask the person to scratch again. Did you now hear the scratching? In which case do you hear the scratch loudly? Which medium conducts sound better: air or wood? Think of an activity to find out whether sound travels through a liquid medium such as water.

How do dolphins and whales which live in water communicate? They produce and use different kinds of sounds and whistles. These sounds travel through water and pass on messages to others. Some species of dolphins send special sounds to identify themselves.

Description of a sound wave: All sound waves are similar in certain respects. However, they may differ in certain characteristics. How can we distinguish between them and describe them? We use certain characteristics of a wave to describe it. This is true of all waves including light and water waves. These characteristics include wavelength, frequency, amplitude and speed. Let us understand the meaning of these terms.

Wavelength: We have learnt that sound is a longitudinal wave. This means that the particles of the medium through which sound travels will show a series of contractions and rarefactions. The particles of the medium vibrate back and forth in the direction of the sound itself.

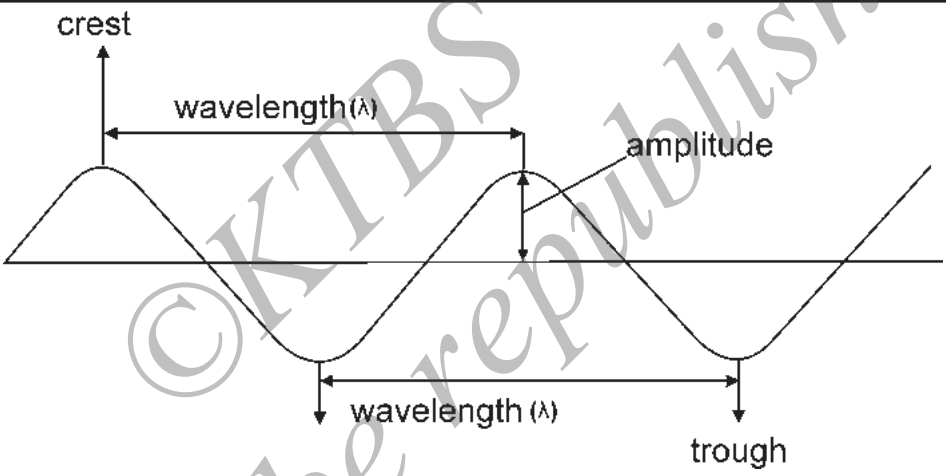


Fig. 14.8 Model of Wave

The distance between two successive compressions is the **wavelength** of the sound wave. See fig. 14.6. This will be same as the distance between two rarefactions. It helps to represent the wavelength by a symbol. The most commonly used symbol for wavelength is λ. It is a Greek alphabet. We read this symbol as 'lambda'. Wavelength actually represents the length of one wave. Different sounds may have different wavelengths.

Frequency: The number of times an object vibrates in one second is called **frequency**. Frequency of a sound wave is same as the frequency of the source. Faster an object vibrates, higher would be its frequency and the frequency of sound it produces.

Let us understand frequency in another way. The propagation of sound involves the travelling of a disturbance in the form of compressions and rarefactions. The number of compressions that pass through a

point in one second will also give the frequency. If 40 compressions pass through a point in one second then, we say that the frequency is 40 hertz. This means that 40 wavelengths are passing through a given point in one second. If 200 compressions pass through a point in 2 seconds, what will be the frequency? How many wavelengths would be passing through in one second? The international unit of frequency is 'hertz'. We use the symbol 'Hz' to represent it.

1 hertz [Hz] = 1 wave per second or cycle per second

Know this : The product of frequency and wavelength of a wave is the velocity of the wave in the medium.

Velocity = frequency × wavelength

Amplitude: Amplitude is another important physical quantity of all waves including sound. The **highest** displacement of a particle from its rest position is the **amplitude** of the sound.

Amplitude of any wave including sound is the 'height' of the wave. You understand this well when you refer fig.14.8. Higher amplitudes cause higher volume of sound. The volume of sound is measured in decibel (dB). At a distance of 1m, loudness of normal conversation is 40 dB. Amplifier is a device that increases amplitude of a wave.

Activity 14.11

Look at fig.14.9. It shows three waves A, B and C of different amplitudes. Assume that these are sound waves. Which of them has the highest amplitude? Which of them has the lowest amplitude? Which one of these waves is the loudest?

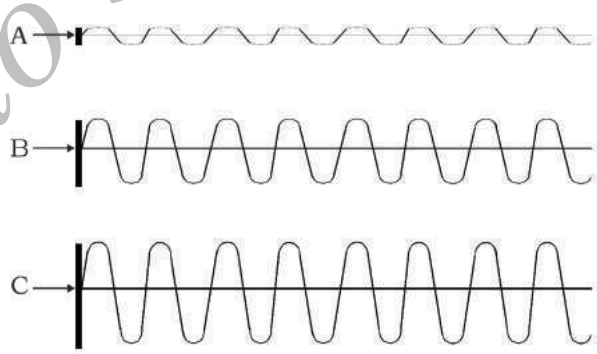


Fig. 14.9 Waves with different amplitudes with same frequencies

Speed of sound: You have studied elsewhere that light travels much faster than sound. You may recall that lightning and thunder

occur simultaneously. However, we see the lightning first and hear the sound of thunder a little later. How fast does sound travel through a medium? We express this in terms of 'speed'. Speed of sound is the distance travelled by it in one second. The S I unit of speed is 'metre per second'. We write this as ms^{-1}.

Know this : The speed of sound through air at 25 ^{0}C at sea level is 346 metre per second or 0.346 km per second. Even most jet airplanes do not travel that fast. When a plane travels faster than speed of sound, the plane breaks the sound barrier and produces a loud sound. This is **sonic boom.** On October 14, 1947, Chuck Yeager did just that in a small plane called the X-1. He was the first person to fly faster than the speed of sound and the listeners on the ground were the first to hear the loud shock waves of the sonic boom.

Echo: What happens when light falls on an obstacle? At least a part of it undergoes reflection. What happens when sound waves strike an obstacle? Do they also come back from the surface the way light does? Let us investigate.

Activity 14.12

Have you heard an echo? Sometimes it happens in big rooms and near the hillside. If you have visited Gol Gumbaz, in Bijapur of Karnataka, you will surely appreciate echo effect. How does this happen? Look at figure 14.10. There are two identical cardboard tubes P and Q. Place tube P at an angle to a metal surface AB. Place a screen S between the two tubes. Keep a small clock at the other end of tube P. Place the other tube Q close to the metal surface at an angle. Bring your ear near the free end of tube Q. Do you hear the tick-tak of the clock? If not, slowly change the position of the tube Q. At some fixed position, you will hear the sound of the clock clearly. How could you hear the sound through tube Q? Recall a similar experiment you did while studying about light.

Find out : What should be the minimum distance between a person shouting and a reflecting surface to hear the echo.?

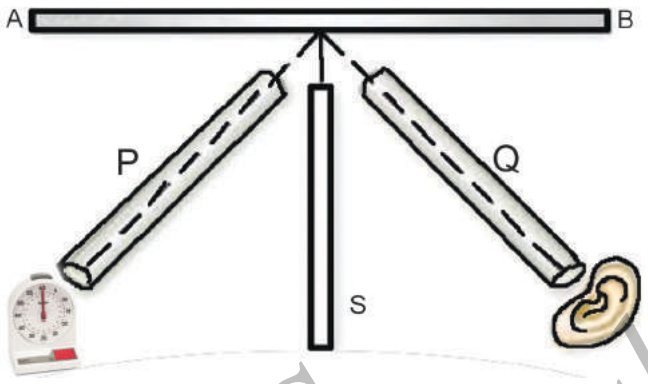


Fig. 14.10 Reflection of sound

When you shout inside an empty hall, you hear your own sound after sometime. This is due to reflection of sound. Surface of obstacles such as walls, mountains, clouds or land reflect sound waves. The 'rolling' of thunder is largely due to successive reflections from the clouds. What happens inside buildings? Furniture, windows, curtains and other materials absorb sound to some extent and reduce reflections. It is important to avoid such reflections inside theatres for clear sound. Reflection of sound finds some wonderful applications in fields such as industry, medicine and entertainment.

Noise and its hazards: We do not like all sounds. Some sounds cause disturbance to humans and other animals. We call all such unwanted sounds as noise. Any excessive sound that causes disturbance to human and animal life leads to noise pollution. Such sounds may come from one or more of several sources such as people, machines or animals. Motor vehicles, horns, loudspeakers, construction and transport systems, aircraft movements, noise of trains may all be quite unpleasant. Sirens, music systems, radio and fireworks may also cause sound pollution.

Loud sounds may cause irritation, headache and loss of concentration. Long exposure to such sounds may lead to loss of sleep, tension and stress, high blood pressure, heart problems and hearing loss. Noise causes many adverse effects on animals. For example, noise is a disadvantage for birds that rely on hearing to locate the prey.

Find out : Collect information about methods of prevention of noise pollution.

Sound is present everywhere. We really take note of it and complain about it only when it is too loud or too soft.

You have learnt

- performing experiments to show that sound is produced by the vibration of bodies.
- various functions of sound in our life.
- the mechanism of transfer of sound through air.
- justification to say that sound is a mechanical wave.
- experiment to show that sound requires a material medium for its propagation.
- comparison of the speeds of sound through solids, liquids and gases.
- definitions of terms of wave length, frequency, amplitude and velocity with respect to a sound wave.
- to show that sound gets reflected from surfaces.
- impact of noise pollution on humans and other organisms.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer:

1. Imagine that you are listening to a popular song from a radio. Using volume control knob, you slightly increase the volume. The factor related to sound wave in this process is, increase in

   a. frequency b. velocity

   c. amplitude d. both frequency and wavelength

2. The velocity of sound is highest in

   a. air b. water c. glass d. vacuum

3. In an unoccupied hall of a choultry you will experience the echo effect of sound. If the same hall is furnished with almirahs, tables, chairs, and other commodities, you may not experience the echo clearly. It is because,

   a. sound waves get absorbed by the objects in the hall.
   b. the area of reflecting surface decreases
   c. reflected sound is reflected again.
   d. sound does not get reflected

4. The factor that is transmitted in wave motion is,

   a. particles of the medium b. vibrations of particles

   c. energy of the cause of the wave d. electrons of the medium

II. Fill in the blanks with suitable words :

1. The product of frequency and wavelength of a sound wave is equal to its _____ .
2. The SI unit of wavelength is _____ .
3. The velocity of sound in air at 25 ^{0}C is approximately _____.

III. Answer the following :

1. Why is sound a longitudinal wave?
2. Explain an activity to show that sound can do work.
3. Describe an activity to show that sound is produced by vibration of materials.
4. Make a list of five musical instruments. State how each of them produces sound.

Musical instrument	The way it produces sound

5. List two applications of reflection of sound.
6. Describe an activity to show that sound requires a material medium for its propagation.
7. Represent a wave graphically. Show in the diagram, the wavelength and amplitude.

Think :

1. Why is sound both a boon and a bane?
2. What measures would you take to minimize the sound disturbance caused to others ?

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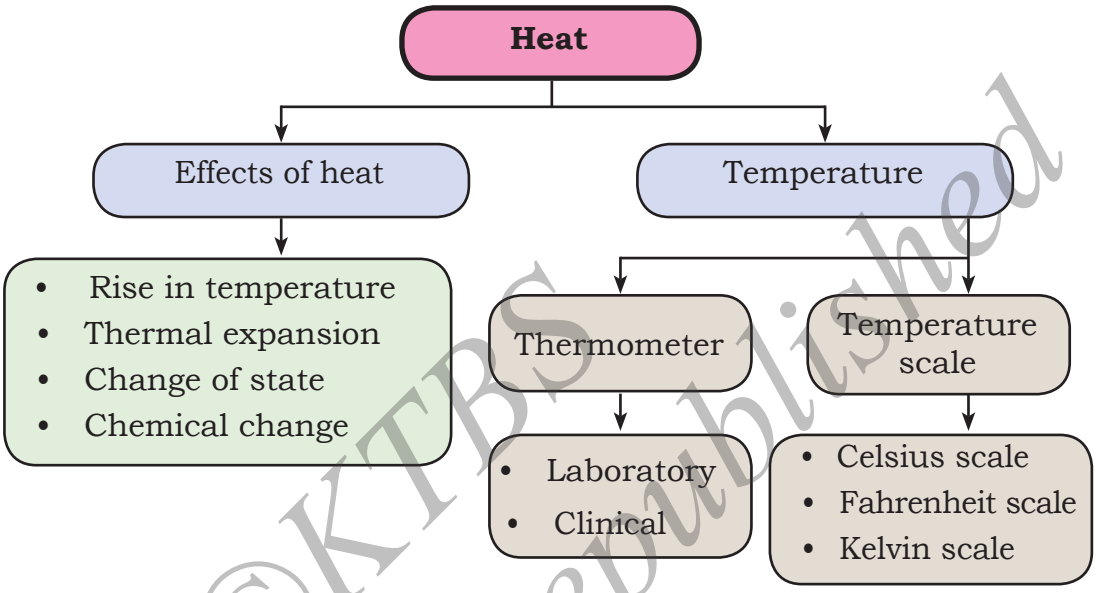
CHAPTER 15

HEAT



You have studied earlier that heat is a form of energy. We use it for several purposes. For instance, we use heat for cooking food. In rubbing of palms, electric ironbox, solar water heater inter conversion of energy is observed. Make a list of activities that require heat. Let us study more about heat energy.

Activity 15.1

Take a cup of water. Put a drop of ink into it. What happens? Why does the ink spread? It is due to the movement of the molecules.

Activity 15.2

Open the cap of a perfume bottle in a corner of a class room. How does the fragrance spread all over the room?

You know that all matter is made up of atoms and molecules. They are always in motion. Hence they have kinetic energy. The total kinetic energy of all the molecules in a substance is called **heat**. The SI unit of heat is **joule** (J). If we heat a substance, we are adding energy to the substance. This added energy can be realised as an increase in the average kinetic energy of the molecules. The molecules now, on an

average, have more kinetic energy. The degree of hotness or coldness of a body is called its ***temperature.***

Temperature

We have been familiar with the sensations of heat and cold since childhood. In some situations by touching the objects, we find out which one is relatively hot. To realize this, let us perform the following activity.

Activity 15.3

Pour hot water,water at room temperature and ice cold water into three separate glass tumblers. Dip the index finger of one hand in the ice cold water and that of the other hand in hot water. Hold the fingers in the water for some time, say about a minute. Then dip both the index fingers into the water at room temperature.

Is the water hot or cold? You will observe that the finger which was previously in contact with hot water will now feel cold, whereas the other finger feels hot.It shows the sensation of degree of hot or cold. The measure of degree of hotness or coldness of a substance is called temperature.

Activity 15.4

Take 100 cm^3 of water and 200 cm^3 of water at the same temperature in two separate beakers. Which has more heat? The heat depends on the mass of the substance. Boil the water in both the beakers. Note the temperature. Are the temperature in the two beakers the same?

Temperature does not depend on the mass of the substance. Temperature is related to the kinetic energy of the molecules. After understanding heat and temperature, let us study the differences between heat and temperature.

Table 15.1 Differences between heat and temperature

Heat	Temperature
Heat is a form of energy	Temperature is a measure of the degree of hotness or coldness of a body.
Heat energy depends on the speed of the particles, the number of particles and the mass of an object.	Temperature does not depend on the mass of an object. For example, temperature of a small cup of water is the same as the temperature of a tub of water. But the tub of water has more heat because it has more water and thus more total thermal energy
S I unit of heat is Joule	SI unit of temperature is Kelvin

Effects of Heat: If we provide heat to a substance its temperature increases.

Activity 15.5

Take a cup of water. Note the temperature. Heat the cup for some time. Note the temperature. What is your conclusion? Heat energy brings about a change in temperature.

Activity 15.6

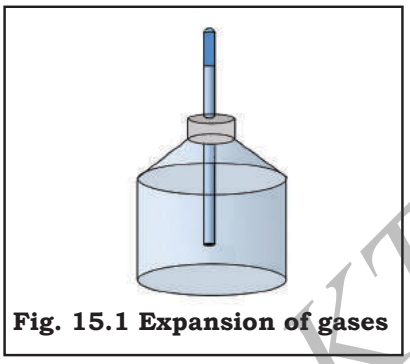


Fig. 15.1 Expansion of gases

Take a glass bottle and insert an empty pen refill as shown in fig 15.1. Put a drop of water at the top of the refill. Hold the bottle tightly. What do you observe? Why is water pushed out from the tube?

Activity15.7

Take a block of ice in a 20 cm^3 beaker. Heat it. What is the change observed? Continue heating till water begins to boil. Observe that the level of water decreases. What can we conclude?

Activity 15.8

Take 10 g of wax in a 20 cm^3 beaker and do the experiment as explained above. Heat energy can bring about a change in the state of a substance.

Activity 15.9

Take one spatula of potassium permanganate in 20 ml test tube and heat it. Introduce a glowing splinter inside the tube. What do you observe? Why is the glowing splinter rekindled? Heat results in chemical change.

Expansion of solids on heating plays an important role in our life.

The expansion of solids by heating

1. If we pour boiling water into a thick glass tumbler, it cracks immediately. The inner surface of the glass becomes hot. So the wall expands. But the outer surface of the glass wall does not expand quickly. This uneven expansion cracks the glass. This is due to the fact that glass is a poor conductor of heat.
2. Have you observed cemented roads? Why is the space left between the small stretches?

3.

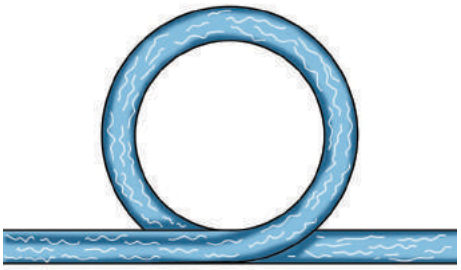


Fig 15.2 Loop of metal pipe

In industries, hot water or molten liquid is transferred from one place to another through metal pipelines. The expansion and contraction might bend or break the pipe. To overcome this, these metal pipelines are provided with loops at regular intervals. The expansion of pipeline causes the size of loop to increase slightly. So the pipe does not break. See fig. 15.2

Other applications

- Thermal expansion of bimetallic strips finds many applications.

It is used as a heat operated switch in the circuit of automatic equipments like iron box (fig 15.3), fire alarms, electric heaters, micro wave oven, refrigerators, incubators and air conditioners.

- Some thermometers work on the principle of expansion of liquids.
- In automobile engines, useful work is done by the expansion of gases.

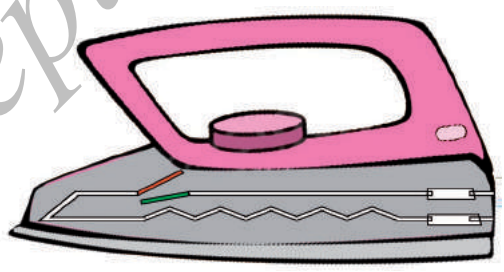


Fig.15.3 Iron box

Anomalous expansion of water

Water on cooling contracts upto 4^0C. Afterwards it starts to expand till it freezes into solid ice at 0^0C. This unusual property of water between 0^0 C and 4^0C is called **anomalous expansion**. It is the abnormal expansion of water instead of contraction when water is cooled from 4^0C to O^0C In simple words water at 4 ^{0}C expands whether it is heated or cooled.

In cold countries as the temperature of air falls below 0^0C, the water in ponds, lakes, rivers and sea freezes at the top to form solid ice. But beneath the ice, water stays at 4^0C. So fish and other aquatic

life can survive in water even when the temperature of air falls to 0^0C. Ice has lower density than water and hence floats on water. It acts like an insulator to maintain the temperature of liquid water.

Thermometer : Thermometer is an instrument that measures the temperature of a system.

You might have observed a mother sensing the temperature of her baby by gentle touch of hand. This practice does not give quantitative measurement of temperature but gives an approximate comparison.

Measurement of Temperature

Most of the thermometers measure temperature by making use of the property of expansion of liquids on heating. A given length of liquid (namely mercury) column increases with increase in temperature. Thermometers are commonly used in our daily life. Now a days, there are digital thermometers also.

Laboratory thermometer

Fig. 15.4 Laboratory thermometer

Laboratory thermometers are used to measure temperature or temperature changes with a high degree of precision. They are made of metal or glass Several types of laboratory thermometers are commonly available in the market. Liquid-in-glass thermometers are made of sealed glass and contain a fluid, usually mercury or red coloured alcohol, whose volume changes with temperature. Bimetallic strip thermometers include two different metals that are bonded together and expand at different rates as they warm up. Often, long bimetallic strips are wound into a coil and used with a dial.

Clinical thermometer

A clinical thermometer is designed for clinical use in humans or animals. It is made of a fine capillary with a bulb filled with mercury at one end. Near the bulb, it has a narrow bend known as 'constriction'. It can prevent the back flow of mercury, when it is taken out of a patient's

mouth or under arm. Before use, the thermometer is given jerks so that the mercury flows back into the bulb.

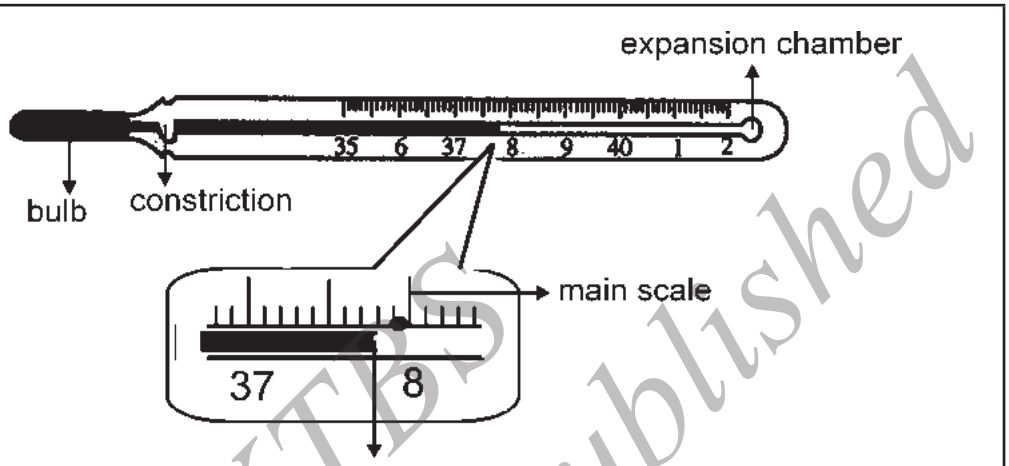


Fig. 15.5 Clinical thermometer

Observe the Fig. 15.5 and note two special features of a clinical thermometer.

The normal temperature of the human body is about 37^0 C which is equivalent to 98.6^0 F. Our body temperature cannot fall below 35^0 C or rise above 42^0 C. Hence, the range of clinical thermometer is between 35^0 C and 42^0 C.

Think : Water cannot be used as a liquid in a thermometer. Why?

Precautions to be taken while using a clinical thermometer:

- Thermometer should be washed before and after each use, preferably with an antiseptic solution.
- Do not wash the thermometer with hot water.
- Ensure that before use the mercury level is below 35 ^{0}C.
- Read the thermometer keeping the level of mercury along the line of sight.
- Handle the thermometer with care, as you handle any glass article.
- Don't hold the thermometer by the bulb while reading it.

Activity15.10

Measure the body temperature of some of your friends (at least 10) with a clinical thermometer. Record your observations (do this activity by keeping the thermometer under arm pit).

Temperature scales

There are three commonly used scales of temperature.

- Celsius scale of temperature
- Fahrenheit scale of temperature
- Kelvin scale of temperature

The temperature is generally measured in degree Celsius. It is denoted as ^{0}C.

There is another unit of temperature namely, degree Fahrenheit which is denoted as ^{0}F.

The SI unit of temperature is Kelvin (K).

Diagram showing comparison of temperature scales

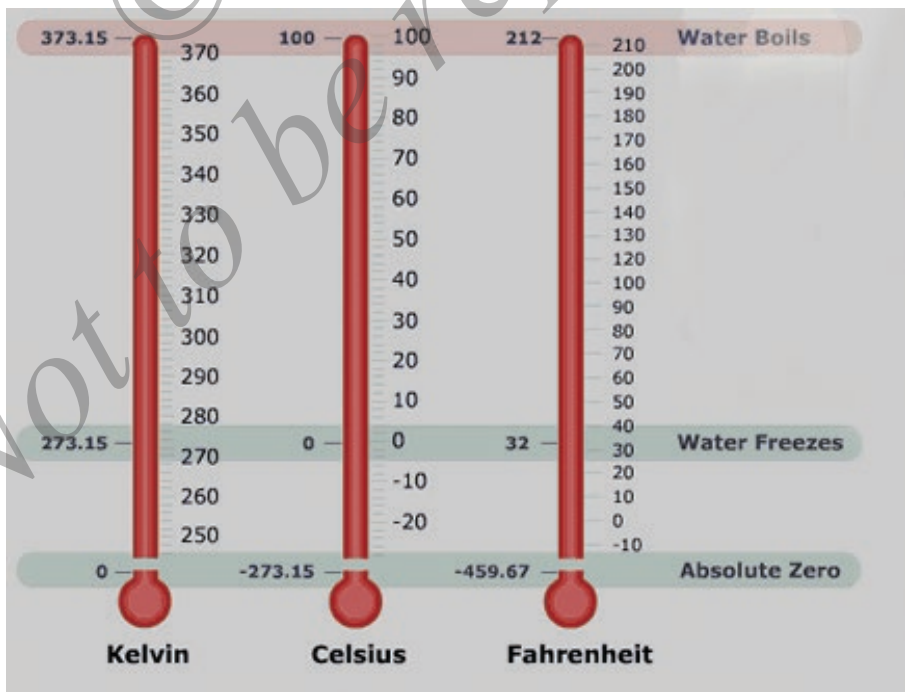


Fig. 15.6 Comparison of temperature scales

In Celsius scale, the temperature of melting point of ice is taken as zero degree and the boiling point of water is 100 degree and the distance between the two is divided into 100 equal parts.

On the Fahrenheit scale, the temperature of the melting point of ice is taken as 32 ^{0}F. The boiling point of water is 212 ^{0}F and the distance between the two is divided into 180 equal parts.

In Kelvin scale, the temperature of the melting point of ice is 273 K and the boiling point of water is 373 K. As in the Celsius scale there are 100 gradations between these two points. Hence the Kelvin scale of temperature is similar to Celsius scale of temperature.

Anders Celsius

Anders Celsius (1701-1744)

The Celsius scale of temperature was earlier referred as the "centigrade" scale. The Celsius scale was developed by Swedish Astronomer Anders Celsius. It has 100 equal divisions between the freezing point (0^0 C) and boiling point (100^0 C) of water. Therefore it is known as centigrade scale. The term "Celsius" was adopted in 1948 by an international conference on weights and measures.

Think : The mercury thermometer is not suitable for measuring very high temperature. Why? Alcohol is used as a thermometric liquid to measure temperatures below 38 ^{0}C. Why?

Conversions

- To convert the Celsius scale of temperature into Kelvin scale of temperature, we have to add 273 to the Celsius scale of temperature.

  For example, 0 ^{0}C is equivalent to 0+273= 273 K.
- To convert the Celsius scale into Fahrenheit scale, formula used is $C = \frac{5}{9}(F - 32)$

Let us study how to use the thermometer to find the boiling point of water and melting point of ice.

Remember

^{o}F to ^{0}C ⟶ Deduct 32, then multiply by 5 then divide by 9

^{0}C to ^{0}F ⟶ multiply by 9, then divide by 5 then add 32.

Activity 15.11

To determine the boiling point of water.

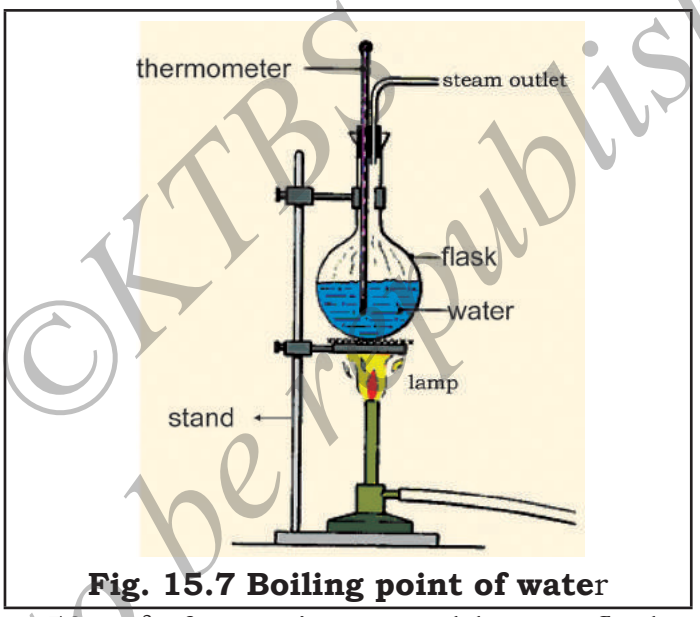


Fig. 15.7 Boiling point of water

Take about 50 cm^3 of water in a round-bottom flask and add a few fragments of broken porcelain. Broken porcelain pieces help in uniform heating of water. Heat the flask and note the temperature when boiling begins. Take readings every thirty seconds for five minutes i.e. ten readings in all, and take the average as the boiling point.

Do this : Add sodium chloride and find the boiling point in this activity.

Presence of soluble salts in water increases the boiling point. Similarly pressure has an effect on boiling point. To maintain the pressure at the same level, steam outlet is necessary. It is importnt to note that whenever a solute is added to a solvent boiling point of solvent increases. Verify this activity by adding salt to water.

In pressure cookers the boiling point of water increases due to the pressure created by blocking of the steam by weight. The weight rises up and lets out the steam if pressure crosses certain limit.

Activity 15.12

To determine the melting point of ice :

Fig. 15.8 Experiment to find melting point of ice

Small ice cubes are taken in a funnel. Funnel is fixed to a stand as shown in fig. 15.8. Thermometer bulb is kept in the funnel such that it is surrounded by ice cubes. Keep a glass bottle below the funnel. Ice begins to melt utilising the heat of the surrounding air. Water thus formed drops out of the funnel. After 10 minutes note down the level of mercury in the thermometer and take the reading which shows the melting point of ice.

Average melting point and boiling points of some common substances are indicated in the table below:

Find out : Are there any factors which influence the freezing point of a substance? Conduct activity 15.12 by adding common salt to ice. What is your conclusion?

Table 15.2. Melting point and Boiling point

Substance	Melting Point Temperature (°C)	Boiling Point Temperature (°C)
Aluminum	659	2,327
Copper	1,083	2,595
Gold	1,063	2,600
Mercury	-38.8	357
Nitrogen	-210	-196
Oxygen	-219	-183
Water	0	100

Convert the boiling and the melting points of the above given substances into Kelvin scale of temperature.

You have learnt

- to define the terms heat and temperature.
- to describe the effect of heat on solids, liquids and gases.
- to mention the application of expansion of solids, liquids, gases in daily life.
- to name the different types of temperature scales.
- to list the advantages of mercury in thermometers.
- to convert Celsius scale of temperature to Fahrenheit scale of temperature and vice-versa.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer:

1. When an object is heated, the molecules that make up the object
   a. begin to move faster b. lose energy
   c. become heavier d. become lighter
2. The temperature of a body is an indicator of
   a. the total energy of the molecules of an object
   b. the average energy of the molecules of an object
   c. the total velocity of the molecules of the object
   d. the average kinetic energy of the molecules of an object
3. A and B are two objects. The temperature of A is greater than that of B. This means that
   a. the molecules of A move faster on an average than the molecules of B
   b. the total energy of A is greater than the total energy of the molecules of B
   c. the average potential energy of A is greater than the average potential energy of B
   d. the heat content of A will always be greater than that of B

II. Fill in the blanks with suitable words:

1. The degree of hotness of a body is called_____(heat/temperature)
2. Temperature is expressed in_____(degree centigrade/joule)
3. A substance changes from liquid to gas at constant temperature. It is called _____(condensation/boiling point)
4. The temperature of boiling water in the Celsius scale of temperature is _____^{0}C (100/373/212/32)
5. The SI unit of heat is _____(Joule/Celsius)

III. State whether the following statements are true or false :

1. Liquids expand on heating.
2. The unit of heat and temperature are the same.
3. Bimetallic strip is used in fans.

IV. Answer the following :

1. Distinguish between heat and temperature.
2. Mention three different effects produced by heat.
3. Give one example to illustrate that heat can be generated from the energy of motion.
4. Describe an experiment to show the change in state on heating.
5. Name two devices which use bimetallic strip.
6. A thick glass tumbler often cracks when boiling water is poured into it. why?
7. State similarities and differences between the laboratory thermometer and the clinical thermometer.
8. Convert 100^0 F in to Celsius and Kelvin scale of temperature.

V. Match the following :

A	B
1. formation of icebergs	a. kelvin scale
2. rise of mercury level in thermometer	b. sudden contraction
3. automatic electric iron	c. celsius scale
4. cracking of hot glass plate when touched by cold object.	d. boiling point
	e. bimetal strip
	f. thermal expansion
	g. anomalous expansion of water

Project Ideas :

1 Meet a veterinary doctor (a doctor who treats animals). Find out the normal body temperature of domestic animals and birds.

2 Write a report on the history of measurement systems using books/ internet for reference.

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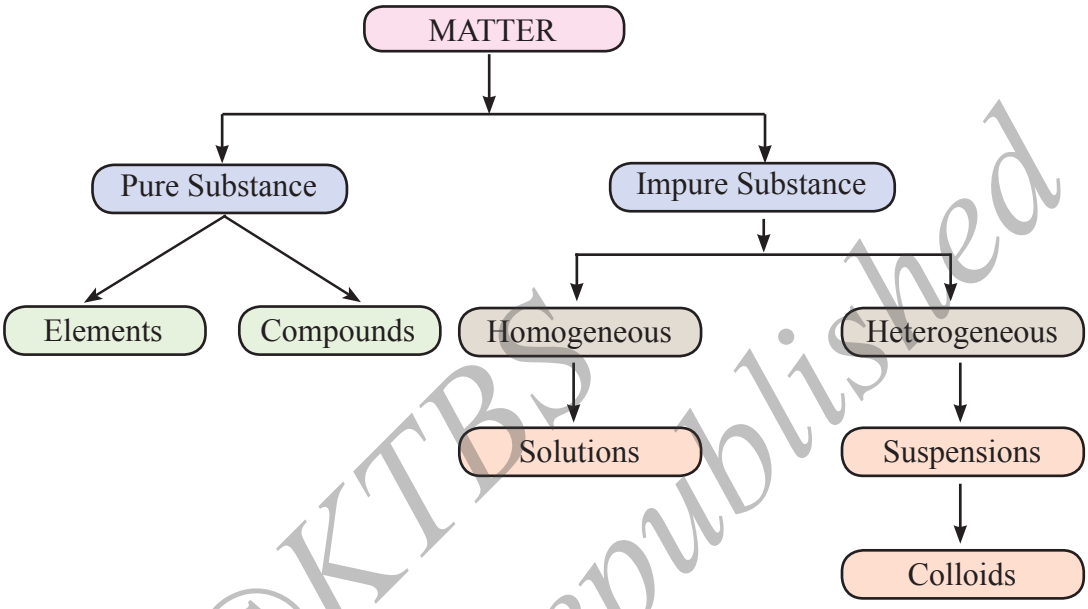
CHAPTER 16

STATES OF MATTER



You have learnt earlier that 'All objects and materials we come across are made up of matter.' Matter is anything that occupies space and has mass. Matter is made up of minute particles called atoms and molecules.

Matter is generally classified into three types called the states of matter. 1. Solids 2. Liquids 3. Gases

Activity 16.1

Make a list of materials around us and classify them as solids, liquids and gases as shown in the table.

Table 16.1

Sl. No.	*Solids*	*Liquids*	*Gases*
1	*Brick*	*Milk*	*Air*
2			
3			
4			
5			

Let us recall the differences between solids, liquids and gases.

Property	Solids	Liquids	Gases
Arrangement of particles	Particles are closely packed. Molecules are fixed to a position and are associated with minimum kinetic energy	Particles are free to move within substances and are associated with more kinetic energy compared to the solid state	Particles are not fixed to a position and are more free than liquids to move in the space available to them. Molecules are associated with maximum kinetic energy.
Shape	They have a definite shape	They assume the shape of the container	Do not have definite shape
Volume	They possess definite volume	They have definite volume	Do not have definite volume
Compressibility	Very low compressibility	Slightly more compressible than solids	Compressibility is very high
Density	High density	Less than that of solids	Very low density

All matter that exists, can be broadly classified into pure and impure substances. Pure substances are those which are formed from the same kind of particles. Elements and Compounds are pure substances.

As we look around us, we can see that most of the matter is made up of two or more components. They are called impure substances.

Eg., : Milk has fat, protein and lactose in it.

Tap water contains water and mineral salts.

Activity 16.2

Take 100mL of water in a beaker and add a spatula of sugar or salt to it. Stir it well. What do you observe.

Now in a glass plate take some salt and add copper sulphate to it. Mix it well. What do you notice.

Mixture

A mixture is a substance formed by mixing two or more substances (elements or compounds) in any proportion so that components do not lose their identity.

Eg :- 22 carat gold is a mixture of gold and copper.

Air is a mixture of Oxygen, Nitrogen, Carbon dioxide and other gases.

Properties of Mixtures

1) A mixture has no properties of its own. The properties of a mixture depends on its constituents.
2) No chemical change takes place during the formation of a mixture.
3) Mixture has no fixed composition.
4) It is generally possible to separate the constituents of a mixture by physical methods

Think! Does the properties of mixtures and compounds one and the same? Discuss with your teacher.

Types of mixtures

In the above activity of mixing salt or sugar in water we get a mixture in which we cannot make out the constituent substances present in it where as in the mixture of salt and copper sulphate we can see the constituent substances present in it. Hence we classify mixtures into Homogeneous mixtures and Heterogeneous mixtures.

Homogeneous Mixture: A mixture is said to be homogeneous if its composition is uniform throughout. The components of a mixture are not visible with a naked eye or even under a microscope.

Eg: Brine solution (saturated salt solution-23% NaCl solution)

Alloys, Air, Crude Oil

Think! Alloys are mixtures. How and why?

Heterogeneous Mixture

A mixture in which different constituents do not mix uniformly is called heterogeneous mixture. The components of mixture are visible to naked eye itself and it is comparatively easy to separate them.

Eg: Mixture of salt and copper sulphate

Mixture of water and oil.

Table 16.2 Examples of Different types of mixtures

Phase	Mixture	Type
Solid in Solid	Alloys such as Brass, Bronze, Stainless steel, ornamental gold,.	Homogeneous
Solid in Solid	Mixture of sand and iron fillings	Heterogeneous
Solid in liquid	Saw dust or chalk dust in water	Heterogeneous
Liquid in gas	Moisture in air	Homogeneous

List some more examples of your own.

Solutions, Suspensions and Colloidal solutions

Solution

A solution is a homogeneous mixture of two or more substances. Usually we consider solution as a liquid that contains either solid, liquid or a gas dissolved in it. But we can also have solid solutions(alloys) and gaseous solutions (air).

A solution has a solvent and a solute as its components.

Solute

The component (solid, liquid or gas) that actually dissolves in a solvent is called the solute. This component of solution is in small quantity.

Solvent

The medium or component in which the solute is dissolved is called the solvent. Usually this component of solution is in large quantity.

Examples: A solution of sugar in water is an example of solid in liquid solution. In this solution, sugar is the solute and water is the solvent.

Water can dissolve large number of substance Hence it is called as UNIVERSAL SOLVENT. Yet there are many other substances which acts as solvent. Some solvents other than water are listed below.

Table 16.3 Solvents other than water.

Solute	Solvent
Iodine	Chloroform, CCl_4, CS_2
Paint	Turpentine oil
Nail Polish	Acetone
Rubber	Petrol

Activity 16.3

Complete the following table with the help of teacher.

Types	Solution	Solute	Solvent
Gas in liquid	Aerated Drinks	Carbon dioxide	Water
Liquid in Liquid	Tincture of Iodine		Alcohol
	Air		
Gas in solid			

More about solution

1) A solution is a homogeneous mixture of solute and solvent.
2) At a particular temperature, if more of the solute can dissolve in the solvent, then the solution is said to be an unsaturated solution.
3) At a temperature, if no more solute can dissolve in the solvent, then the solution is said to be a saturated solution.
4) Increase in temperature to a certain extent will result in more solute getting dissolved in solvent.
5) Heating of saturated solution increases the solubility of solute in the solution.

Know this : what is meant by solubility?

Suspension

A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium.

Generally in suspension liquid media will be solvent and solute will be the solid substances dispersed in it. Particles of a suspension are visible to the naked eye.

Example: saw dust or chalk dust (solute) added to water (solvent).

Properties of suspension:

1. Suspension is a heterogeneous mixture.
2. The particles of a suspension can be seen by the naked eye.
3. The particles of a suspension scatter a beam of light passing through it and make its path visible.
4. The solute particles settle down when a suspension is left undisturbed.

Do you know : Suspension medicine!

Activity 16.4

Take some water in a beaker and add few drops of milk to it. Milk will spread uniformly throughout water.

Colloidal Solution

A colloidal solution is a solution in which a material is evenly suspended in a liquid. They are sometimes also referred as colloidal suspension. Here microscopically small particles called colloid is equally dispersed throughout the another material.

Eg : Milk

Water into which few drops of ink is added.

In colloidal solutions due to the relatively smaller size of particles, as compared to that of a suspension, the mixture appears to be homogeneous. But actually, a colloidal solution is a heterogeneous mixture. As the colloidal particles are very small in size we cannot see them with naked eyes. But, these particles can easily scatter a beam of visible light propagating through it.

Properties of colloids

1) A colloid is a heterogeneous mixture.
2) The size of particles of colloid is too small to be individually seen by naked eyes.
3) Unlike suspensions, they do not settle down when left undisturbed. Colloidal solution is quite stable.

Activity 16.5

Observe the beam of light from projector. What do you notice?

Tyndall effect

The scattering of a beam of light by the colloids is called the Tyndall effect. It is after the name of the scientists who discovered this effect. Tyndall effect can also be observed when a fine beam of light enters a room through a small hole.

Tyndall effect can be observed when sunlight passes through the canopy of a dense forest. In the forest, mist contains tiny droplets of water, which act as particles of colloid dispersed in the air.

The components of a colloidal solution are the dispersed phase and the dispersion medium. The solute–like component or the dispersed particles in a colloid forms the dispersed phase and the component (solvent) in which the dispersed phase is suspended is known as the dispersing medium.

Classification of Colloids

Colloids are classified according to the state of the dispersing medium (solid, liquid and gas) of the dispersing phase.

Different types of colloids are listed along with examples.

Table 16.3 Different types of colloids

Dispersed Phase	Dispersing medium	Type	Example
Liquid	Gas	Aerosol	Fog, cloud, mist
Solid	Gas	Aerosol	Smoke, automobile exhaust
Gas	Liquid	Foam	Shaving cream
Liquid	Liquid	Emulsion	Milk, face cream
Solid	Liquid	Sol	Milk of magnesia, mud
Gas	Solid	Foam	Foamrubber, sponge, pumice
Liquid	Solid	Gel	Jelly, cheese, butter
Solid	Solid	Solid Sol	Coloured gemstone, milky glass

Brownian movement

The random motion (zig-zag motion) of small Colloidal particles suspended in a liquid or gas medium is called as Brownian movement. This is caused by the collision of the medium's molecules with the particles.

It is named after the botanist Robert Brown who observed the movement of plant spores floating in water.

You have learnt

- Classification of matter as solids, liquids and gases.
- Classification of matter as pure and impure substances
- Meaning and properties of mixtures.
- Types of mixtures.
- Meaning and components of solution.
- Properties of solution.
- Meaning and properties of suspension
- Meaning, properties & classification of Colloides.
- Tyndall effect.

EXERCISES

I. Four alternatives are given to each of the following statement/ question. Choose the right answer.

1. Which of the following does not hold good for liquid?
   a. They have definite volume
   b. They are slightly compressible than solids.
   c. Molecules free to move within the substance.
   d. They have definite shape and size.
2. Which of the following is not a pure substance?
   a. Common salt b. Sugar
   c. Rain water d. Iron

3. The component which is not present in air is

   a. Nitrogen b. Oxygen

   c. Carbon dioxide d. Chlorine

4. Butter is an example for

   a. Liquid in solid b. Solid in liquid

   c. Liquid in liquid d. Solid in solid.

II. Answer the following questions.

1. Write any four differences between solids, liquids and gases
2. Differentiate between homogeneous and heterogeneous solution with an example to each.
3. Give an example to each of the following.

   a. Suspension b. Colloidal solution.

4. Define:

   a. Tyndall effect b. Brownian movement.

5. Give any two examples for solvents other than water.

III. Give scientific reason for the following :

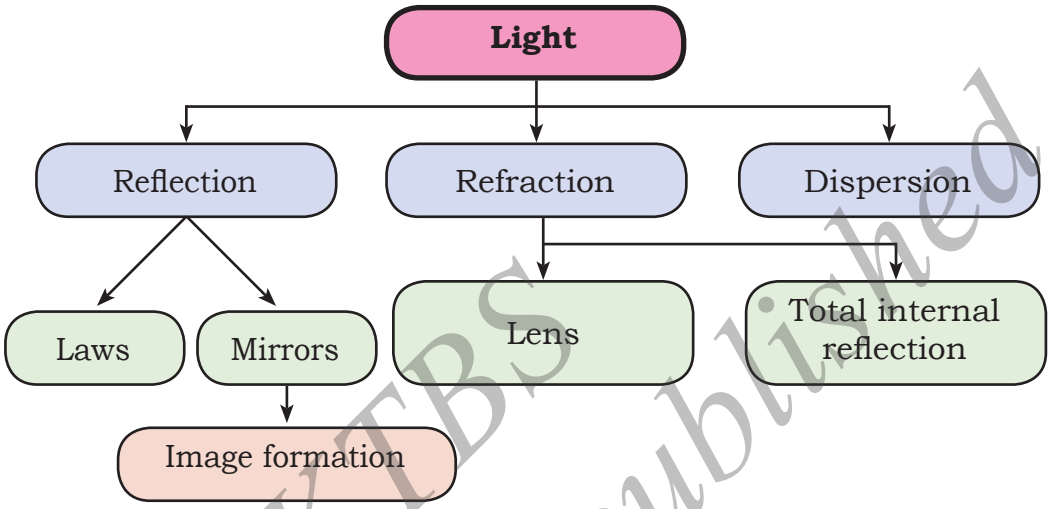
1. Gases do not have definite shape and volume.
2. Ornamental gold is an example for homogeneous mixture.
3. Mixture of sand and iron fillings is heterogeneous mixture.
4. Water is called the universal solvent
5. When a beam of light is passed through a suspension, its path is visible.

IV. Match the following:

1. Sodium chloride	a) Impure substance
2. Milk	b) Suspension solution
3. Air	c) Pure substance
	d) Mixture

CHAPTER 17

OUR COLOURFUL WORLD



Light

Light enables us to see the objects surrounding us. Our eyes sense the objects by the light reflected by them or when the objects emit light. Plants carry out photosysthesis with the help of light energy and prepare food. In photocells light can be changed into electrical energy. Light has all the characteristics of energy.

Reflection: You are familiar with the usage of mirrors, seeing your images in new steel plates, tumblers or spoons. You have seen multiple images in hair cutting saloons. You have seen images in the rear view mirror of motor vehicles.

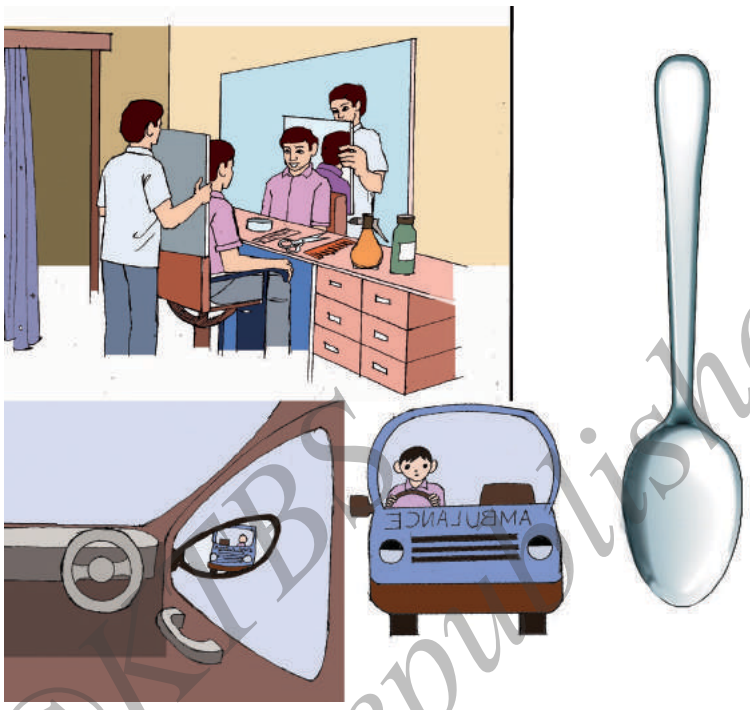


Fig. 17.1 Reflection of light in different situations

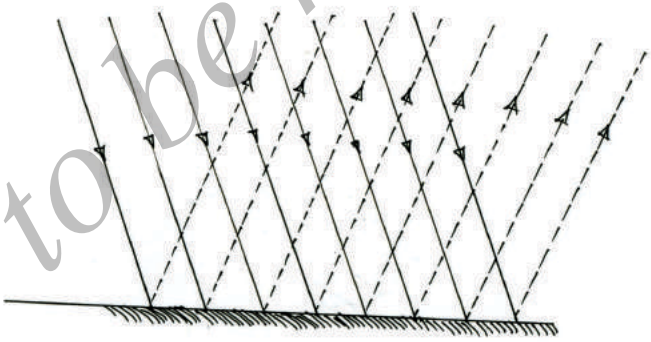


Fig. 17.2 Regular reflection

You cannot see your image on a wall. But you can see your image in a mirror. In both the cases there is reflection. What is the difference?

Regular reflection: In a perfectly flat and polished surface, a parallel beam of light is reflected as a parallel beam. Such a reflection is called "Regular reflection". Images are formed in regular reflection.

Irregular or diffused reflection: Objects having rough and unpolished surface reflect a parallel beam of light in all directions. Light gets scattered and images are not formed.

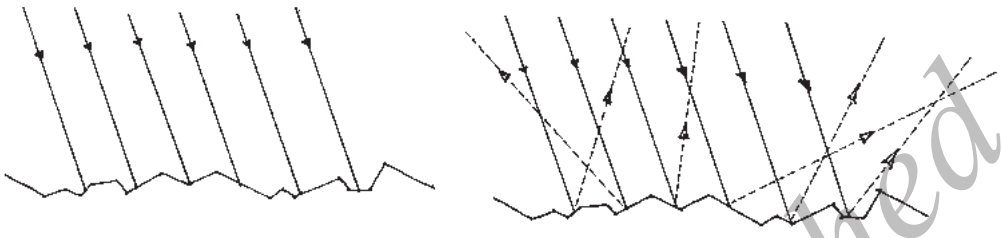


Fig. 17.3 Rays reflected from irregular or rough surface

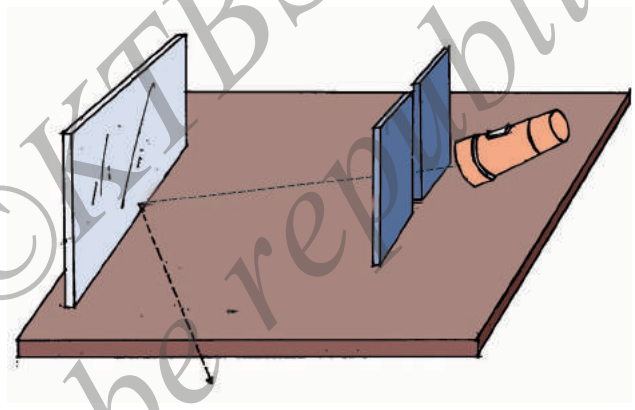


Fig. 17.4 Experiment: Laws of reflection

To know more about the pattern of reflection let us do an activity.

Activity 17.1

Take a small mirror strip. Take a cardboard and make a slit at the centre as shown in fig. 17.4.

You can use the back of a ready made shirt box as the stand.

Keep a white sheet of paper on one side of the hollow box and pin it at the four corners. Make incisions on the box as per size of the cardboard slit and mirror and keep it on the table. Fix the mirror strip and the cardboard slit perpendicularly in the incisions made. Pass light from a torch through the opening of the cardboard slit, from an angle. We can see light ray getting reflected after striking the mirror.

The light ray which strikes any surface is called the incident ray. The ray that comes back from the surface after reflection is known as the reflected ray.

Now carefully draw a line on the paper with the help of a pencil to mark the position of the mirror, the incident ray and the reflected ray. Remove the mirror and torch. Draw a perpendicular line to the mirror at the point where the incident ray strikes the mirror. This line is called the "normal" to the reflecting surface at that point.(see Fig. 17.5)

Word help: 'Normal' usually means perpendicular

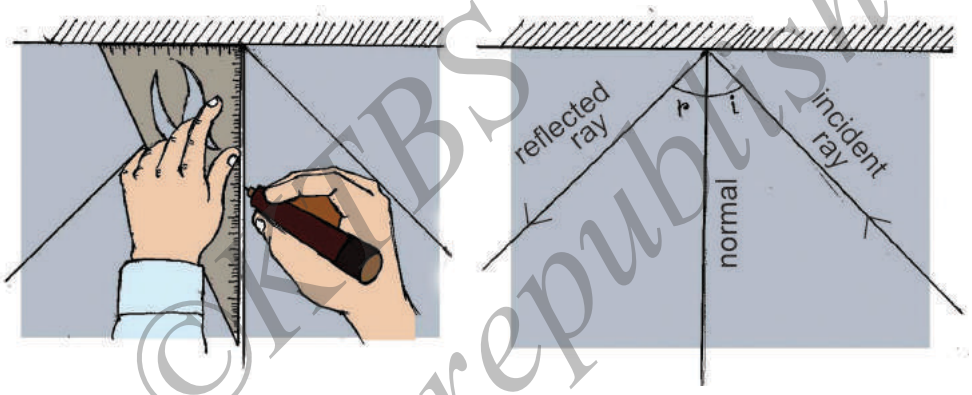


Fig. 17.5 Laws of reflection

The angle between the normal and the incident ray is called the angle of incidence ($\angle i$). The angle between the normal and the reflected ray is known as the angle of reflection ($\angle r$). Measure the angle of incidence and the angle of reflection. Repeat the activity several times by changing the angle of incidence. Tabulate the measurements.

Table 17.1

Sl. No.	Angle of incidence ($\angle i$)	Angle of reflection ($\angle r$)
1.		
2.		
3.		
4.		
5.		

Compare the angle of incidence and angle of reflection.

What is your conclusion?

What happens if a light ray is incident along the line of normal?

Activity 17.2

Set up the experiment as in activity 17.1, insert a scale below the white paper in the plane of reflected ray. Slightly raise the plane of the reflected ray. The reflected ray does not appear in the raised plane. This means incident ray and reflected ray lie on the same plane.

Laws of reflection

- Angle of incidence is equal to the angle of reflection.
- The incident ray, the normal drawn to the mirror at the point of incidence and the reflected ray all lie on the same plane.

Laws of reflection are valid for all types of surfaces.

How is image formed in a plane mirror? What will be its nature?

A source of light 'O' is placed in front of a plane mirror PQ. Two rays OA and OC are incident on it.(See Fig. 17.6)

Draw normals to the surface of the mirror PQ at the points A and C. Then draw the reflected rays AB and CD at the points A and C respectively. Extend them further. Do they meet? Extend them backwards. Do they meet now? Mark this point as 'I'.

For a viewer's eye at 'E' the reflected rays appear to come from the point 'I'. The reflected rays appear to meet at I. It is a virtual image and can not be caught on a screen. The image is also laterally inverted. (Fig. 17.7) That means left of the object will become right of the image and right of the object will become left of the image. The image on a plane mirror is erect and it is as far behind the mirror as the object is in front of it. In irregular reflection though the laws of reflection are followed, the reflected rays are scattered and image is not formed.

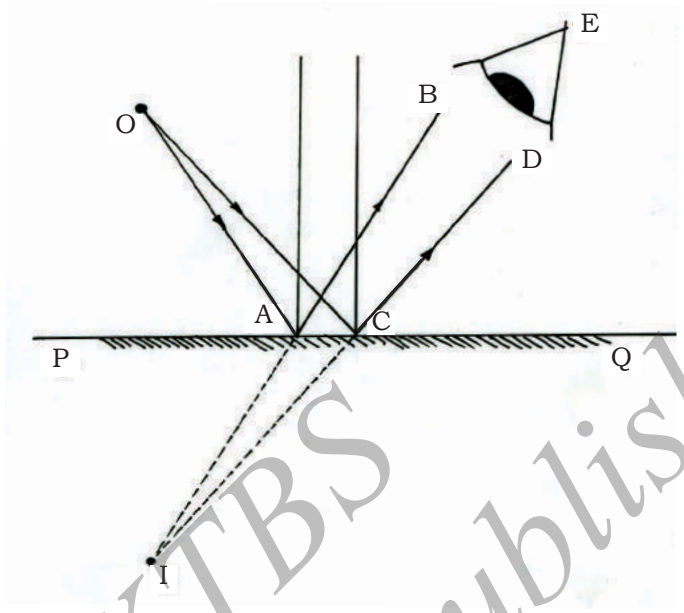


Fig. 17.6 Image formation in a plane mirror

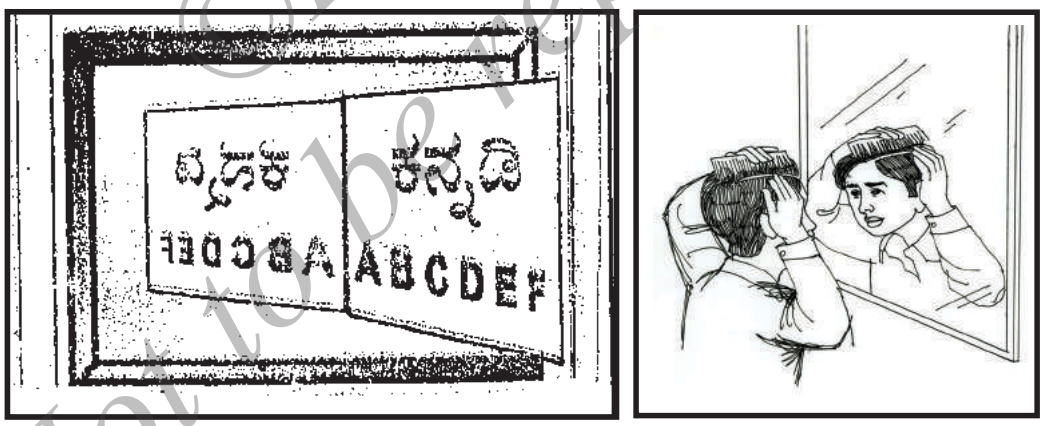


Fig. 17.7 Lateral Inversion

Know this : Virtual images cannot be caught on a screen. Whereas real images can be caught on the screen.

Reflection in a curved mirror

You might have seen many curved reflecting surfaces.

Mainly there are two types of curved surfaces, concave and convex. A new stainless steel spoon will be enough to see the pattern of images.

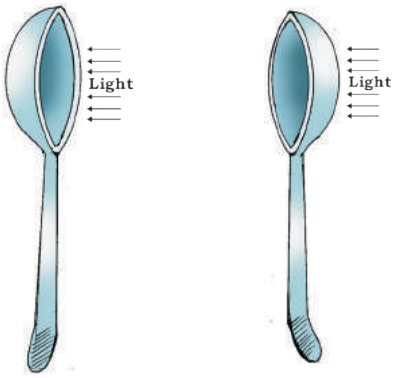
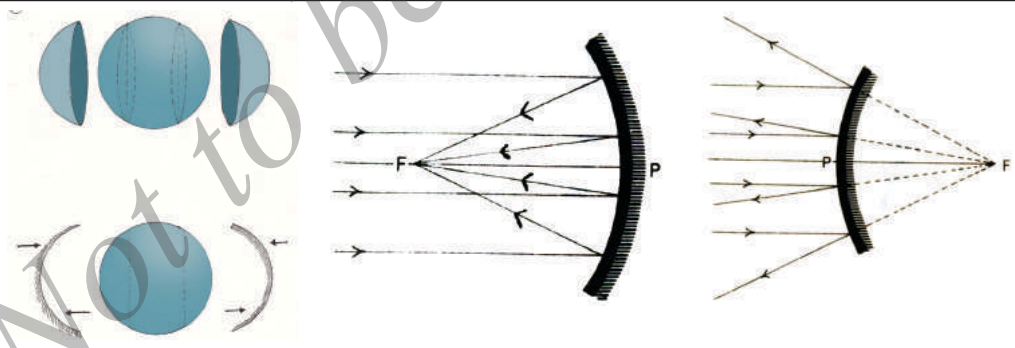


Fig. 17.8 **Fig. 17.9**
Reflection in a stainless steel spoon

Hold the spoon as in the figure 17.8 in front of your face. You see your image. Hold the spoon at different distances from your face. What is your observation?

Hold the spoon as in the fig. 17.9 in front of your face. You see your image. What is your observation?

Spherical Mirrors: Spherical mirror is a part of a sphere with polished surface on one of the sides. There are two types of spherical mirrors- concave mirror and convex mirror.



Concave mirror - Convex mirror
The point of convergence is `F'. P - pole of the mirror

Fig. 17.10 Spherical mirrors

Spherical mirrors also obey the laws of reflection. Each part of the spherical mirror can be considered as strips of small plane mirrors.

Activity 17.3

Repeat the activity 17.1. This time, insert a concave mirror first and after removing it insert a convex mirror in the incision made for plane mirror. In place of the slit, place a comb such that only 4 to 5 teeth of the comb are exposed to the torch light. This can be done by covering the rest of the comb by a piece of black paper. Observe the pattern of reflected rays.

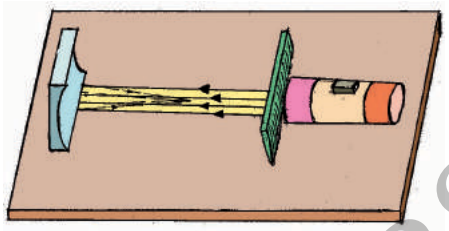


Fig.17.11 Reflection in concave mirror

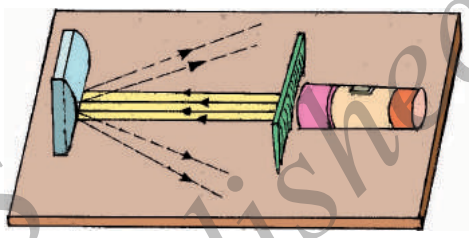
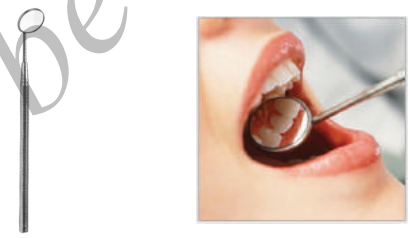


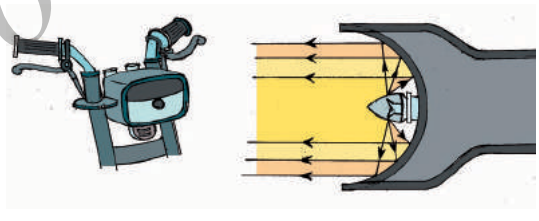
Fig 17.12 Reflection in convex mirror

Concave mirrors are used by dentists, in solar furnace and in head lights of motor vehicles. Convex mirrors are used as rear view mirrors in automobiles.

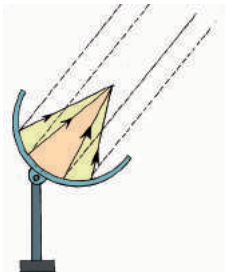
Know this : Convex mirrors always produce diminished virtual images of an object. The principal focus 'F' of a convex mirror lies behind the reflecting surface on the principal axis. (fig : 17.10)



Concave mirror used by dentists



Enlarged view of head light of vehicle



Solar furnace

Fig. 17.13 Uses of curved mirror

Image formation in a concave mirror

You need to know the following terms to study the nature of the image formed by a concave mirror.

1. **Pole of the mirror:** usually the pole of the mirror is located at the mid point of the curved surface of the mirror. The ray of light along the principal axis which is incident on the pole of the mirror retraces its path, along the principal axis. It is the centre of the reflecting surface.

2. **Principal focus:** It is the point of convergence of a parallel beam of light which is also parallel to principal axis, after reflection from the mirror. Light from a distant source such as sun rays are sources of parallel beam of light. It is denoted as `F'.

3. **Focal length:** The distance between the pole of the mirror and the point of focus of reflected parallel rays of light which are incident on the mirror is called focal length. It is denoted by 'f '.

4. **Centre of curvature:** It is the centre of the sphere of which the mirror is a part. It is denoted by the letter 'C'

5. **Radius of the curvature:** The radius of the sphere of which the mirror is a part is called radius of curvature. It is denoted by 'r'. Radius of curvature will be twice the focal length. (r=2f).

6. **Principal axis:** The imaginary extended line on which the pole of the mirror, the point of focus and the centre of curvature are located is called principal axis.

7. **Object distance:** The distance of the object from the pole of the mirror is called object distance. It is denoted by 'u'.

8. **Image distance:** The distance between the mirror and the image is called image distance. It is denoted by 'v'.

Experiment:- *To know the nature and position of the image formed by a concave mirror. Take a lighted candle as the object, mirror and a screen.*

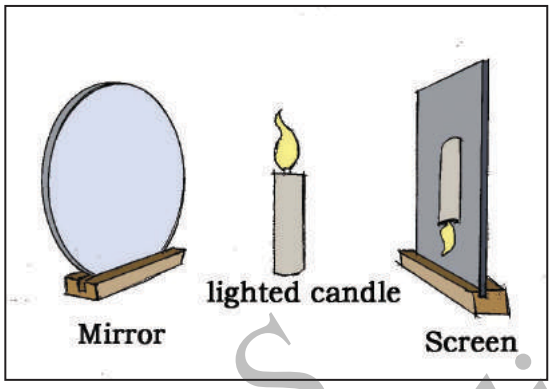


Fig 17.14 Image formation in a concave mirror

Keep a lighted candle in front of the mirror at different places on the principal axis and adjust the screen by moving it to and fro to get a clear image of the candle on the screen.

Finding the approximate focal length of a concave mirror

First find out the approximate focal length by focusing a source of parallel beam of light. Mark the position as F. At a distance of 2f from the mirror, mark the radius of curvature of the mirror as 'C'. Keep the candle on the principal axis at the following places and record your observations.

1. Between pole of the mirror and F
2. At F
3. Between F and C
4. On C
5. Beyond 'C'

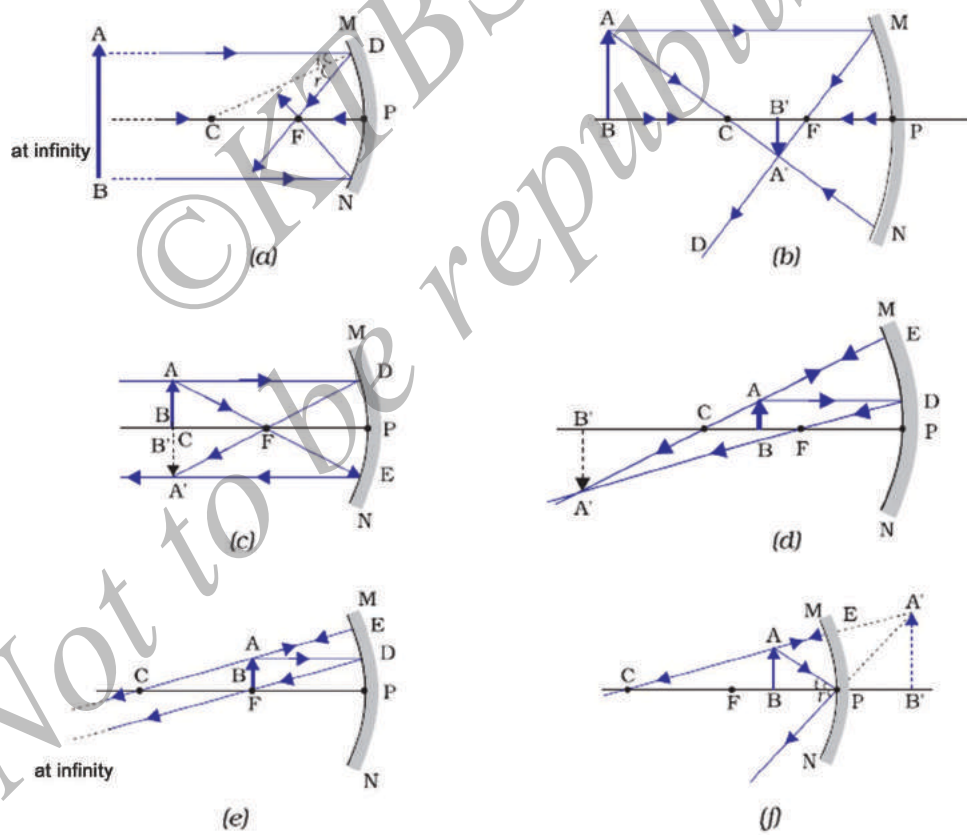
The nature and position of image formed in a concave mirror depend on the position of the object placed in front of the concave mirror.

The intersection of atleast two reflected rays gives the position of image of the point object. Any two of the following rays can be considered for locating the image.

1. An incident ray parallel to the principal axis of the concave mirror will pass through the principal focus after reflection.

2. An incident ray passing through the principle focus of a concave mirror will be parallel to the principal axis after reflection.

3. An incident ray passing through the centre of curvature after reflection, is refleted back along the same path.



Formation of images when the object is placed at various distances as shown in column 1 Record your observations in the table

Table 17.2

1	2	3
Position and distance of the object	Position and distance of the image	Nature of the image (Inverted or diminished or same size or enlarged)
a. At infinity	principal focus	
b. Beyond C, ... cm	You have to adjust the screen between 'F' and 'C' . . . . . cm	
c. At C . . . . . cm	You have to adjust the screen near the object . . cm	
d. Between 'C' and 'F' . . . cm	You have to adjust the screen beyond C . . . . . cm	
e. At 'F'	You will not get the image, why?	
f. Between the mirror and F	You will not get the image on the screen. You will not be able to measure the distance of the image, why? But you can see its virtual image on the mirror.	

From the above table can you answer the following?

1. Where should the object be placed to get a diminished image of the object on the screen?
2. Where should the object be placed to get an enlarged image of the object on the screen?
3. Where should the object be placed to get parallel beam of light ?

If the focal length is 'f', image distance is v, object distance is 'u' you will notice from the table that

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \text{ or } f = \frac{uv}{v+u}$$

$$\text{or focal length} = \frac{\text{Product of image distance and object distance}}{\text{Sum of image distance and object distance}}$$

Refraction:

You have studied about opaque and transparent substances.

Glass and clear water are familiar examples of transparent substances.

What happens when a ray of light passes from one transparent medium to another transparent medium?

Recall your experiences.

1. The bottom of a water tank appears to be raised.
2. A Pencil partially immersed in an oblique manner at an angle in water appears to be bent.
3. A coin in a cup which is just invisible from an angle can be made visible by pouring water in the cup.

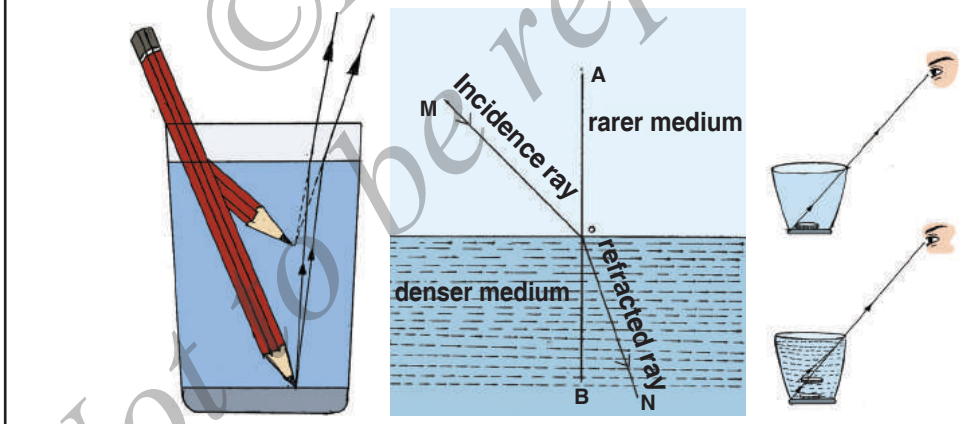


Fig. 17.15 Refraction of light rays

Refraction is the bending of light when it passes from one transparent medium to another of different density. Like laws of reflection, is there any relationship between the angle of incidence and the angle of refraction?

AB is normal at the point of incidence, O is point of incidence, MO is incident ray and ON is refracted ray. (see fig. 17.15)

Since water is a denser medium than air, when an oblique ray of light travels from rarer medium to denser medium it bends towards the normal. That means angle of refraction will be smaller than angle of incidence.

Imagine NO as incident ray and OM as refracted ray (see fig.17.15). Then we can say that when light passes from denser medium to rarer medium it bends away from the normal. That means angle of refraction will be greater than the angle of incidence.

Activity 17.4

Preparation of Refraction bottle:

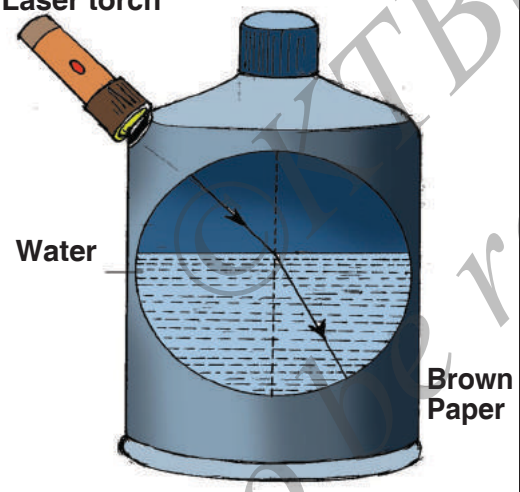


Fig 17.16 Preparation of Refraction bottle

Obtain a flat bottle, like used perfume bottle or honey bottle. Similar clear plastic bottles can also be used. Cover the bottle with brown paper, cutting out a circular piece on one of its flat sides. (Follow the diagram).

Pour water until half of this circular opening is filled up. Add two drops of milk to water. Through a small opening at the top corner, pass a powerful beam of light. A key chain laser torch can also be used. Use the laser torch carefully. Avoid direct viewing into the laser light.

Compare angle of incidence and angle of refraction, using a thin stick as normal at the point of incidence.

Another effect of refraction of light is twinkling of stars.

Total Internal reflection

If you observe carefully an aquarium which contains a light source at the bottom you observe the effect of total internal reflection.

Imagine rays of light OA, OB, OC and OD from a denser medium striking water surface at A, B, C, and D respectively. $AA^1/$, $BB^1/$, $CC^1/$ are refracted rays. But DD^1 is reflected ray. This is called total internal reflection.

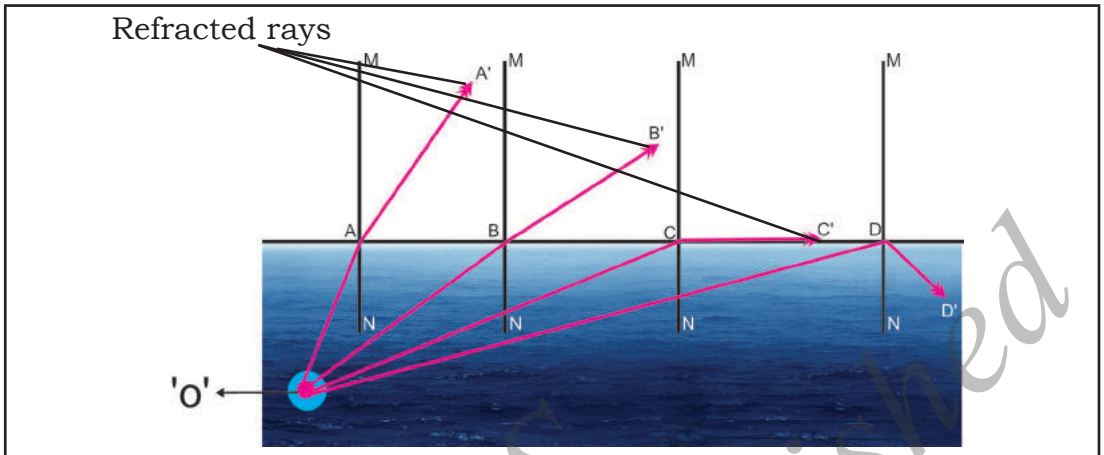


Fig.17.17 Total Internal reflection

The angle of incidence ($\angle OCN$) for which angle of refraction is 90^0 ($\angle MCC^1$) is called critical angle. Remember that, for total internal reflection the following conditions are necessary.

1. Light ray should pass from denser medium to rarer medium.
2. The angle of incidence must be larger than the critical angle.

Effects of total internal reflection

Mirage : People in hot dry area usually observe this frequently. Desert travellers sometimes see the image of palm trees as if there was water near the tree.

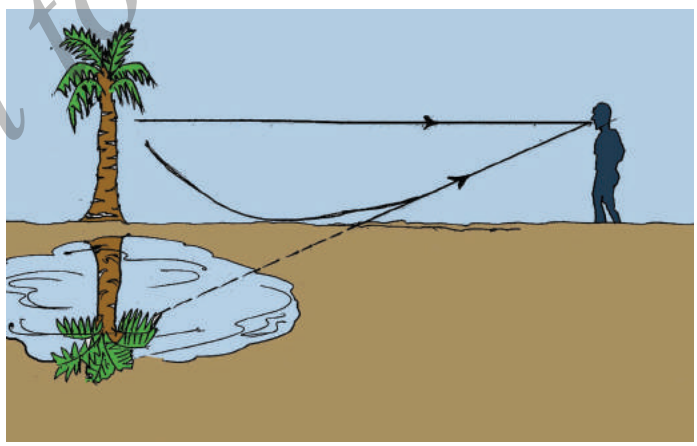


Fig. 17.18 Mirage

In the above diagram which part of the air (that is lower or upper) is a rarer medium?

Mirage like effect can also be seen on very hot days which gives an illusion of pool of water at the far end of the road. We can see the illusion on the upper part of a hot plate also. Light from the sun is bent by the hot air near the earth. The sparkling of diamond is also an effect of total internal reflection of light.

The principle of total internal reflection is used in optic fibres which is used in communication.

Refraction of light through curved transparent medium

Activity 17.5

Take a glass plate; place a drop of clear water on it. Observe the letters of a newspaper through the water drop. The letters appear big.

Activity 17.6

Take a glass tumbler with clean water in it. Dip your finger and observe the finger from the side of the tumbler. The finger appears big. (See fig. 17.19)

Like curved mirrors there are curved transparent media.

Lenses : Recall your study about lenses in class VII. Any curved piece of transparent material is called a lens. They are part of a spherical transparent medium. They can be curved on one side or both the sides.

They are useful for bending light as required.

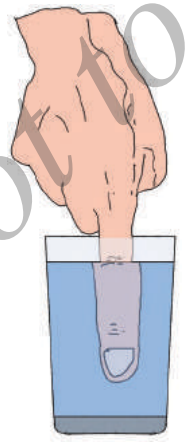


Fig. 17.19
Effect of a convex lens -

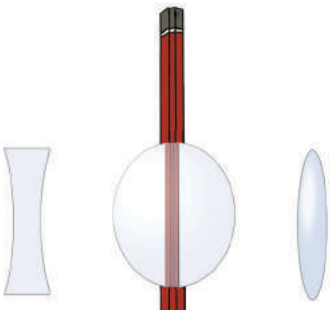


Fig. 17.20
Effect of a concave lens -

Fig. 17.21
Effect of a convex lens

There are two types of lenses - convex and concave. See the fig .17.20 and 17.21.

Activity 17.7

Use a card board, like the one used to study the laws of reflection using a comb and torch. You can perform the following experiment to know that convex lens converges the light rays and concave lens diverges the light rays.

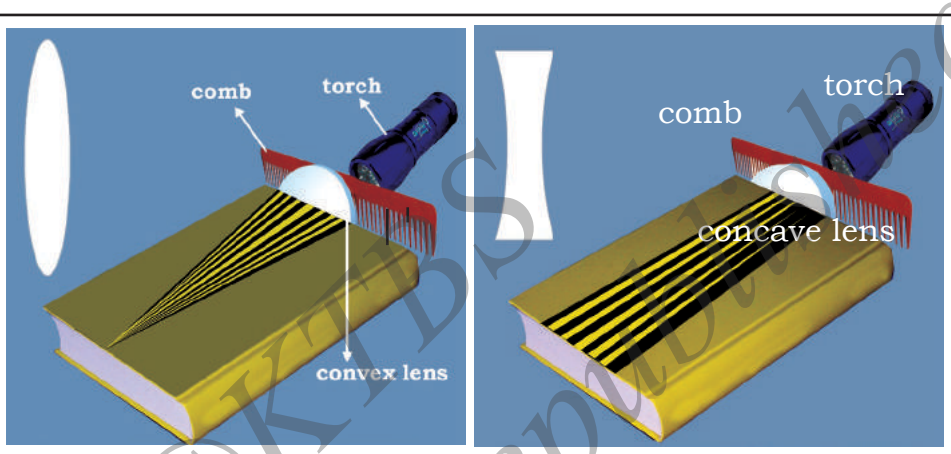


Fig. 17.22 Light rays passing through convex and concave lenses

Like concave mirrors we can use convex lens to get inverted, diminished or enlarged images of an object, which can be caught on a screen.

Concave lens never forms real images. They form diminished images of objects. This is useful in view finder of cameras, where we can see large area in small space.

Fig. 17.23 Things which contain lenses

Do you have a convex lens with you?

Yes. you do have. Your eyes contain convex lenses. How does the lens help us to see? This lens is not made of glass, but a soft jelly like substance. Discuss with your teacher.

Dispersion of light : You are familiar with rainbows. You have seen rainbow like colours in soap bubbles, in fountains, and compact disc (CD) of computer devices.

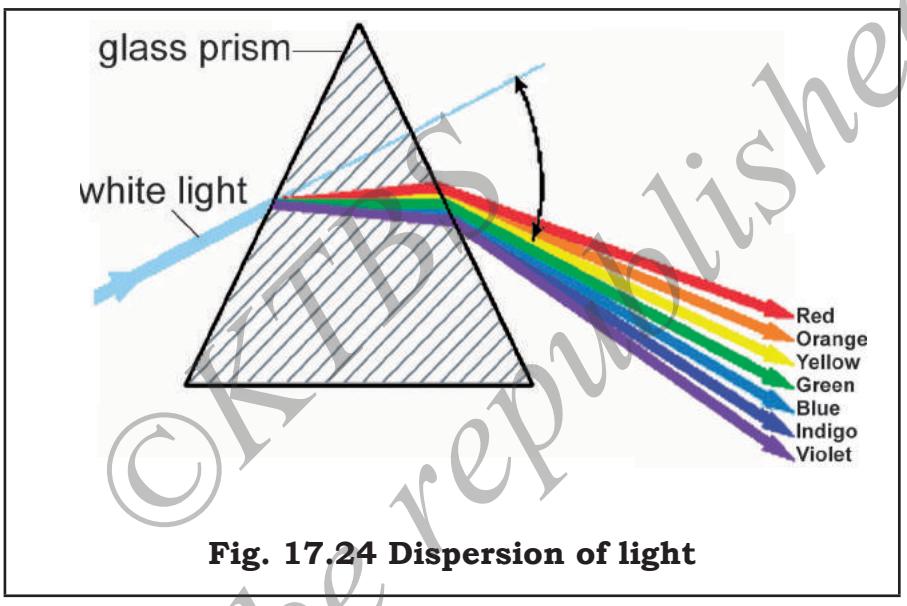


Fig. 17.24 Dispersion of light

White light is made up of a range of seven colours. The splitting up of white light into its constituent colours is called dispersion. In the rainbow you may not see all the seven colours. It is due to overlapping of colours.

With the help of a narrow beam of light, glass prism and arrangement of lenses it is possible to produce the band of seven colours using white light. This band is called spectrum. There are many types of spectra.

It is not necessary that the source of light should always be white to get a spectrum. A glowing 40 W tungsten filament bulb does not produce pure white light. It is a source of composite light. It will also produce

a spectrum but the spectrum may not be the same as the spectrum of white light. The type of spectrum depends on the nature of source of light.

Activity 17.9

Produce a band of colours:

Immerse a plane mirror in an inclined position in a bowl containing water. Let the reflecting surface be partially or fully immersed in water as shown in the figure. Allow sun rays to fall on the reflecting surface of the mirror immersed in water. Catch the reflected rays on a screen of white paper. You will see band of colours like rainbow. You will study more about lenses and dispersion of light in higher classes.

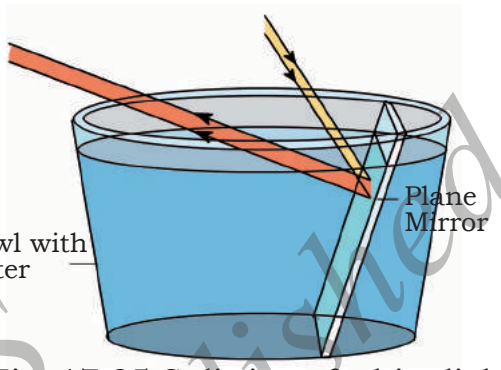


Fig. 17.25 Splitting of white light

you have learnt to :

- distinguish between regular and irregular reflections.
- state the laws of reflection.
- represent image formation in a plane mirror geometrically.
- state the uses of concave and convex mirrors.
- calculate the focal length when image distance and object distance are given for a concave mirror.
- tabulate the data of experimental observations.
- draw diagrams showing convergence and divergence of parallel rays of light when incident on concave mirror and convex mirror.
- define refraction.
- state the effects of refraction.
- explain the meaning of the terms
  1. total internal reflection 2. critical angle
- explain the effects of total internal reflection.
- name optical instruments containing convex lens and concave lens.
- define dispersion of light.
- illustrate by examples, the dispersion of light in daily life.
- give reasons for the formation of mirages.

EXERCISES

I. Four altertnatives are given to each of the following incomplete statements / questions. Choose the right answer:

1. Rear view mirror of motor vehicles is a

   a. plane mirror b. convex mirror

   c. concave mirror d. convex lens

2. If a ray of light is travelling from denser medium to rarer medium and if the angle of incidence is greater than critical angle, then the following takes place

   a. total internal reflection b. refraction

   c. dispersion d. multiple refraction

3. A concave mirror forms magnified inverted image when the object is placed at

   a. 'F' b. 'C' c. between 'F' and'C' d. beyond 'C'

4. On a new stainless steel spoon if you see the image of your face upside down, then that part of the spoon acts like,

   a. convex lens b. concave mirror

   c. convex mirror d. concave lens

5. You can see the image of your face on the surface of stagnant water. But if the water is disturbed, your image will not be clear because of

   a. total internal reflection b. refraction

   c. irregular reflection d. dispersion

II. Fill in the blanks with suitable words :

1. The letter "P" looks like _____ in a plane mirror.
2. The type of lens used by watch repairers is _____.
3. Bending of light when it passes from one transparent medium to another is called _____.
4. Formation of rainbow is due to _____ .

III. Answer the following:

1. Give one reason to prove that light is a form of energy.
2. What is the difference between regular and irregular reflections?
3. State the laws of reflection.
4. Mention the uses of concave mirrors.
5. Why is convex mirror used as rear view mirror in motor vehicles?
6. Mention any two effects of refraction of light in daily life.
7. What are the conditions for total internal reflection to take place?
8. Write diagrams to show the refraction of parallel rays of light in (i) convex lens and (ii) concave lens.
9. Mention any four devices that contain convex lens.
10. What is dispersion of light?

IV. Match the following:

1. dispersion	a. plane mirror
2. diminished image	b. concave lens
3. laterally inverted image	c. mirage
4. total internal reflection	d. convex mirror
	e. rainbow
	f. multiple reflections
	g. glass slab

Extended learning activities. preparation of multipurpose beam box

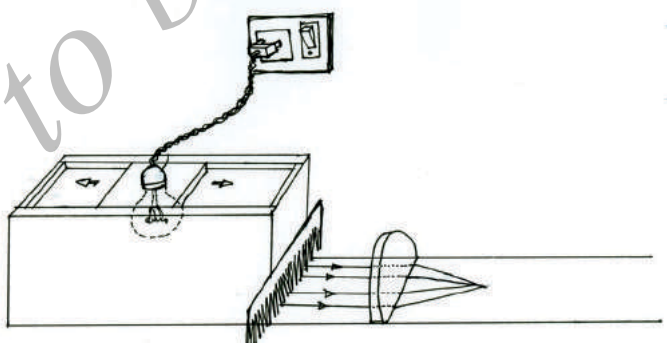
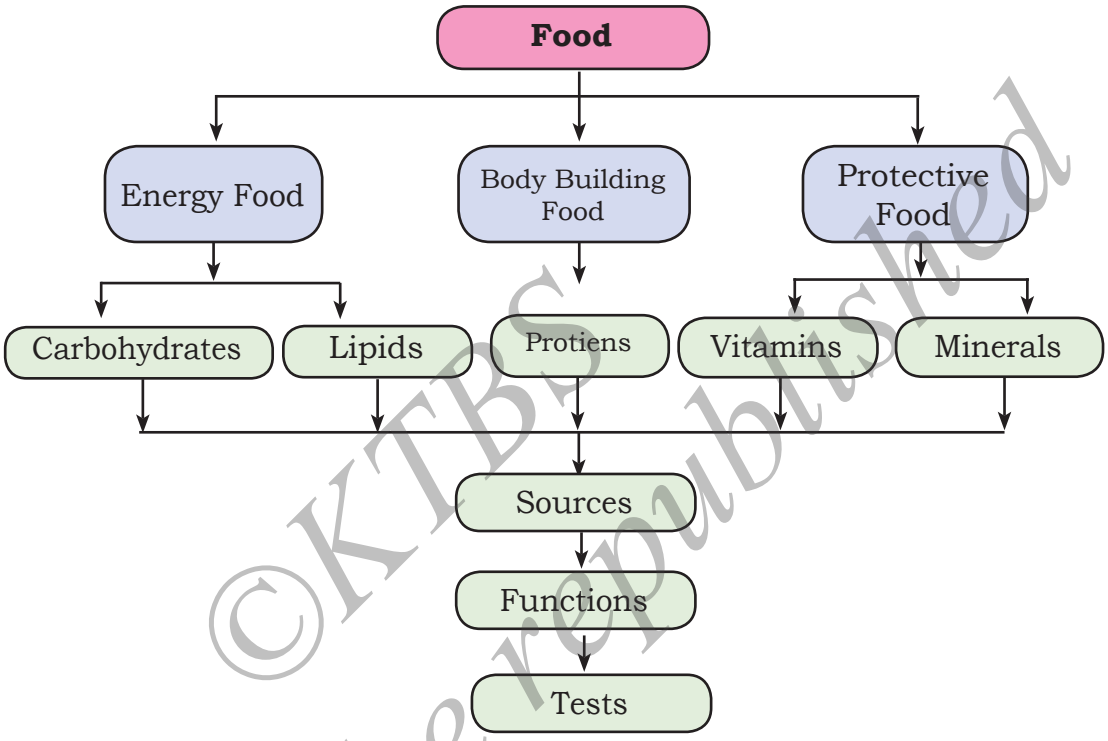


Fig. 17.26 Beam box

You need the help of a carpenter for this. A rectangular shoe box type wooden box and photo frame cardboards with the white paper pasted on it are required. Also a 40 to 60 watt bulb and bulb holder, a comb are needed. The diagram 17.26 will make it clear.

CHAPTER 18

FOOD AND ITS CONSTITUENTS



All organisms have a number of requirements to survive, grow and remain active. They include air, water and food. No organism can survive for long without food. One of the several things that are common to all living beings is that, they all need food to survive, remain healthy and to carry out various activities. Humans are no exception to this.

Food becomes your blood and bones, brain and muscles. Food becomes your size and strength, energy and stamina. Food contributes to your physique, effectiveness and emotional stability.

We know so much about food. What is food then? Food provides the necessary nutrients and energy to the body.

Think : Are there any items in your view which are a part of food although they do not provide energy to our body?

Water does not provide nutrients, but water is very essential to our body. Can we consider water as part of our food?

General Functions of food

Every living organism including humans needs energy. Energy enables us to move, grow, and reproduce. Is this the only purpose of food? The purposes of food are mainly three fold. Food promotes growth, supplies energy and furnishes nutrients for the repair of body parts. Every breath, every thought, every movement wears out some portion of our body. Various vital processes remove the worn out and useless cells. The body compensates for these losses by constantly renewed supply of materials through food and drink.

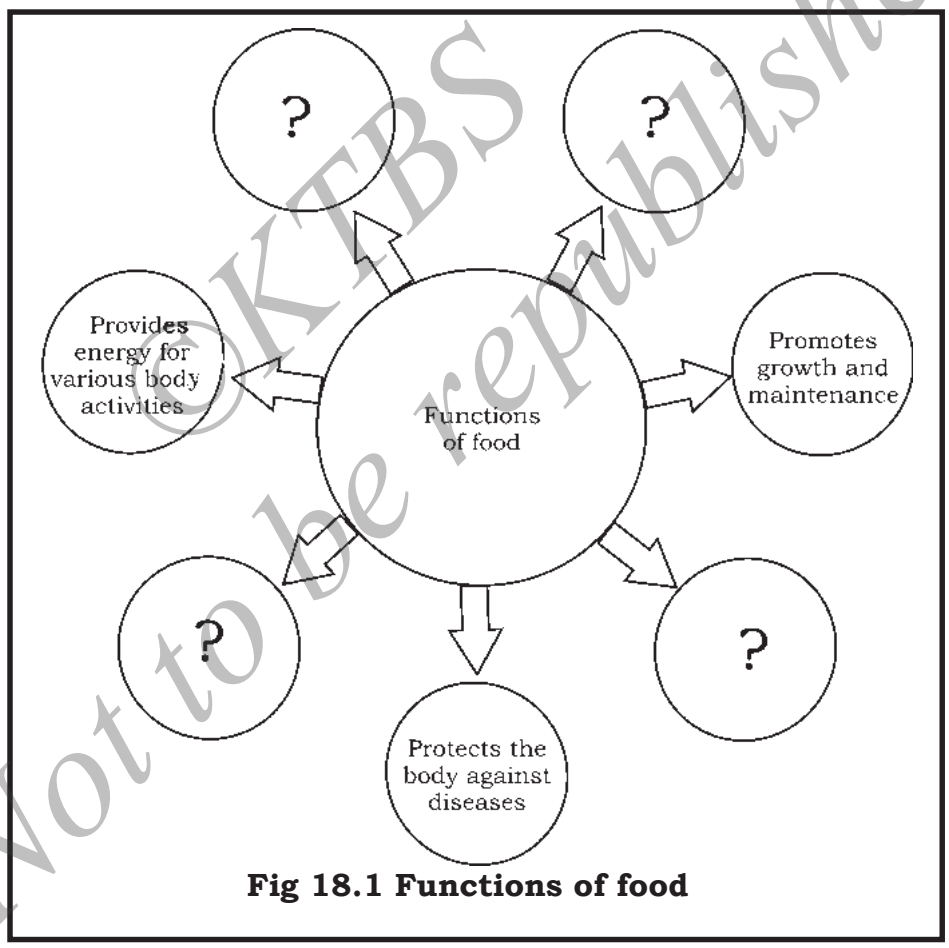


Fig 18.1 Functions of food

Our body has to carry out many functions. Different functions require different materials. Even if we get enough food to fill our stomach, we can be unhealthy. This is because we do not get all essential elements from just one type of food. Hence, we need to eat different kinds of food to get all the nutrients required for the body.

Activity 18.1

Is there variety in the food you eat? What are the various types of food items normally used at home? Do all families use the same types of food? Find out. What factors determine the type of food we eat?

Find out : What happens, if we do not get adequate food? Discuss the problems that arise out of hunger. All countries and regions have atleast some people who suffer from hunger. Is it fair? Does it not reflect that we are living in an unequal society? What are your views on this? Discuss how the people in the world can work together so that everyone will have enough and the right kind of food to eat.

Constituents of food: Food contains nourishing substances called nutrients. They keep our body fit and active. Different kinds of food contain different nutrients essential to our body. The food may also contain constituents that do not supply any nutrients. These non-nourishing materials are however essential to our body. Hence, they should form an integral part of our food. They include fibre and water.

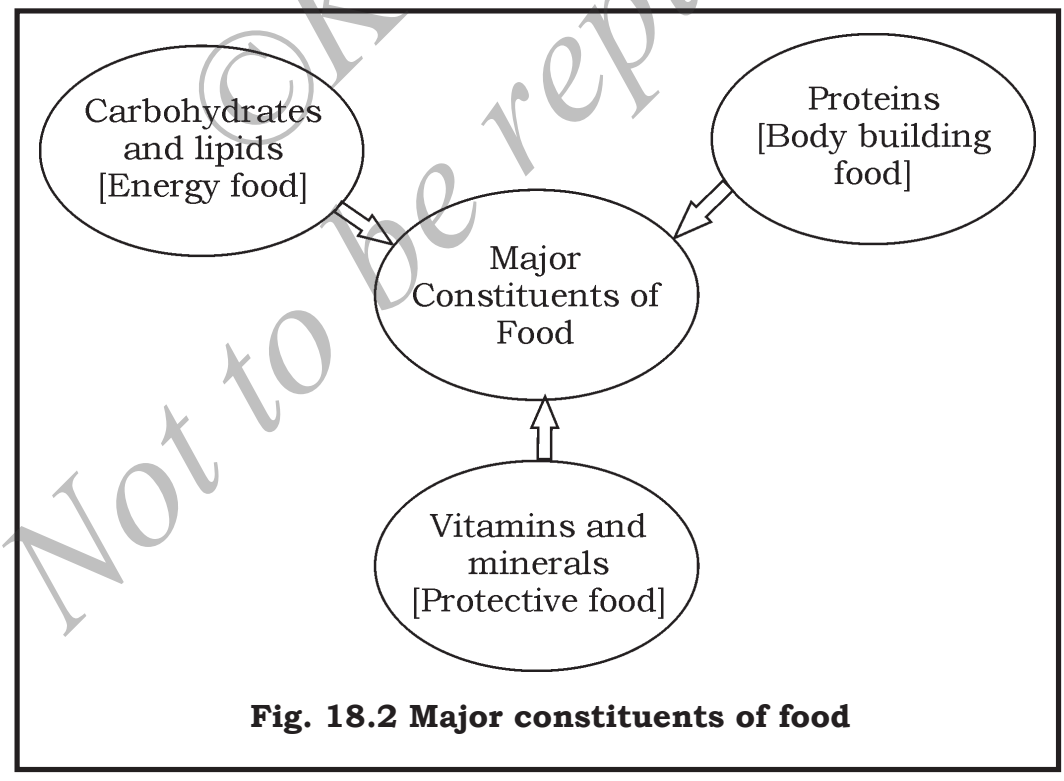


Fig. 18.2 Major constituents of food

Scientists have identified many nutrients in our food. Each of these has a specific function. There are three major nutrients. They are energy

giving nutrients, protective nutrients and body building nutrients. You have studied in your earlier classes about these nutrients. Knowing about nutrients, their sources and functions adds purpose to our eating habits. Further, it helps us to choose the type of food we eat.

Energy giving food

All our activities require energy. Our body needs energy even when we are sleeping. Our energy supply comes mainly from cereals. Sugar, jaggery, some kinds of fruits and potatoes contain large quantity of **carbohydrates.** These are the compounds made of carbon, hydrogen and oxygen. We also get energy from oils, butter and ghee. Nuts and meat also contain fair quantity of oils and fats. We refer to oils and fats as **lipids.** They serve as concentrated energy food.

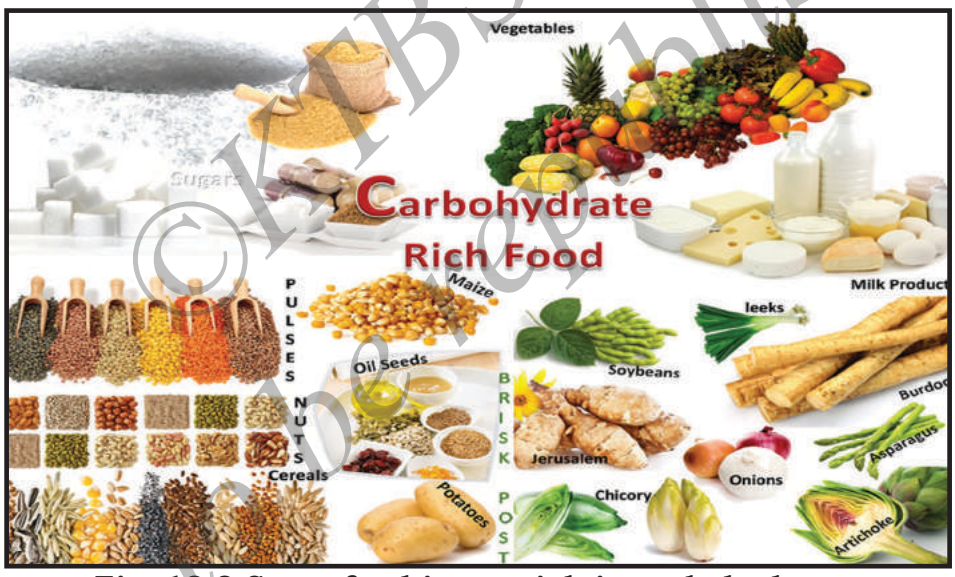


Fig. 18.3 Some food items rich in carbohydrates

Carbohydrates on digestion turn into glucose. Glucose gets into the blood. The blood supplies glucose to all cells of the body. Any inadequacy or excess of glucose might lead to adverse effects. Insufficient supply of glucose may lead to tiredness, weakness and lack of concentration. Excess of glucose can add to our weight and diseases like diabetes. Hence, we must take carbohydrates in moderate quantity.

Functions and principal sources of Carbohydrates

The regulation of sugar in the blood stream ensures adequate supply of carbohydrates to every cell. Complex carbohydrates such as cellulose are excellent source of fibre. Fruits, dairy products, jaggery, sugar and vegetables provide simple carbohydrates.

Activity 18.2

Figure 18.3 shows some sources of carbohydrates. Observe the figure and make a list of food items rich in carbohydrates.

A person with more physical activity needs more carbohydrates. Unused carbohydrates in the body are stored up as fats. Persons with sedentary life style must be careful. Excessive collection of fats in the body may result in overweight and obesity. This may in turn lead to many other health problems.

Think: Athletes and sports people after an intense activity consume glucose. How does this help? Which is better in such situations: glucose, common sugar or baked potatoes? Why do you think so?

As you already know, carbohydrates and lipids supply energy to our body.

The functions of carbohydrates are multiple. Therefore, it is necessary to include carbohydrates in our diet. For instant energy generation, sugars and starch are perfect fuels. They help to carry out physical activities efficiently and effectively. Fibres containing carbohydrates such as cellulose keep bowel movement smooth. Consumption of carbohydrates in different foods will also pave way for consumption of other essential nutrients. Therefore, it is necessary to go in for variety of carbohydrate food sources. Carbohydrates add to the taste. We use some of them as sweets. It is better to go in for natural slow digesting carbohydrates like vegetables, fruits, nuts, legumes and whole grains.

Functions and principal sources of lipids

Lipids consist of molecules made of carbon, hydrogen and oxygen. They are insoluble in water. There are several types of lipids including oils and fats.

Lipids play a very important role in our body. They help in brain functioning, smooth movement of joints, clotting of blood and energy production. Different lipids have different functions. For instance, some lipids help to bring down inflammation within the body and lubricate the joints. Our body makes some lipids and we get some from our diet.

Fig. 18.4 Food items rich in lipids

Fat helps the body to absorb and to move the vitamins A, D, E, and K through the bloodstream. Our body would lack in these vitamins in the absence of lipids. Cell membranes contain lipids. As a protective barrier, it controls the movement of materials. Lipids store energy and hence help in energy production. However, excess lipids may cause heart disease. Regular exercise and physical activity can control the problem. Lipids also act as messengers within our body. Fats also help to maintain healthy skin and hair. Thus, lipids are most essential to life.

Most lipids of plant origin are in the form of oils. These are relatively healthier. Most fats, on the other hand, come from animal sources. They are not good for health. Doctors usually do not recommend butter, cheese, whole milk, ice cream, cream, fatty meats, coconut and palm oil for some people.

Functions and principal sources of proteins

Proteins are very important molecules in our cells. They are involved in all cell functions. There are varieties of proteins, which are typically formed from a set of 20 simple compounds called amino acids. Some amino acids must be a part of our diet as they are not synthesized in our body (essential amino acids). We must plan our food to get these amino acids. Most amino acid molecules include atoms of carbon (C), hydrogen (H), a carboxyl group (-COOH) and an amino group ($-NH_2$].

Each of the dietary protein has a specific structure. The structure determines the function of proteins in our body. Some proteins are involved in structural support, some in body movement and yet others assist in building up defence against germs. You might have heard of enzymes. They are also proteins. which increase the rate of biochemical

Fig 18.5 Some food items rich in proteins

reactions inside our body. For example, there is an enzyme called pepsin. It plays an important role in digestion. It works in the stomach to break down proteins in food. Similarly, there is another enzyme called lactase. It breaks down the sugar present in the milk. Several hormones in our

body are proteins. They are messenger proteins. For example, insulin helps in the metabolism of carbohydrates. It is one such messenger protein. You must have heard of haemoglobin. This protein is present in our blood. It plays a crucial role in the transport of oxygen in our body. Some proteins like keratin and collagen are fibrous and tough. They provide support to tendons and ligaments.

Combining variety of right food together in a meal will give adequate proteins to our body. The body uses these proteins for maintaining healthy growth.

Activity 18.3

Which are the food items rich in proteins? Look for information on this or consult a doctor. Make a list of them. What else can you do to improve your protein intake?

Functions and principal sources of vitamins and minerals

Vitamins and minerals are required in smaller quantities for maintaining health. They are called micronutrients. Vitamins are essentially organic compounds. There are several well-recognized vitamins. Some of them like vitamin C and vitamin B are water-soluble. Others like vitamin A, D, K and E are fat-soluble. We also need certain substances like beta-carotene and folic acid, which get converted into vitamins in our body. We call such substances as **pro-vitamins.** For example, beta-carotene gets converted into vitamin A in our body. All these vitamins and pro-vitamins promote our health. Table 18.1 gives various vitamins, their functions and their sources:

Think : Does your diet provide you with all the vitamins? Do you know people who suffer from ailments of one kind or the other due to vitamin deficiency? Find out.

Table 18.1: Some vitamins, their functions and sources

Vitamin	Functions	Some Natural Sources
A	Promotes skeletal growth, normal tooth structure, healthy skin, eyes and night vision.	Fish liver oils, liver, milk, carrots, greens, papaya and yellow vegetables, dairy products.
B1	Helps to convert sugar and starches into energy; promotes digestion, strengthens heart muscle, promotes growth; prevents fatigue	Whole wheat, dried yeast, oat meal, peanuts, pork, prawn, sunflower seeds, soyabean sprouts.
B2	Helps in releasing energy to body cells; enables utilization of fats, proteins and sugars.	Dairy products, liver, kidney, yeast, leafy greens, fish, eggs, milk.
B3	Helps to maintain a healthy digestive tract and nervous system. In very large doses, lowers cholesterol	Mushrooms, prawn, tuna, chicken, beef, peanuts, enriched grains.
B6	Involved in amino acid metabolism, prevents certain skin disorders, retarded growth and convulsions	Cereals, grains, yeast, liver, milk, wheat germ, meat, beef, bananas, eggs.
B12	Promotes utilization of protein, fats and carbohydrates; essential for formation of red blood cells; builds nucleic acid; prevents anaemia; helps the nervous system.	Liver, beef, pork, eggs, dairy products, shellfish.

C	Needed for absorption of iron, some proteins and folic acid; prevents oxidation of other vitamins; stops internal bleeding; strengthens blood vessels, maintains bones and teeth; promotes stamina; holds body cells together, prevents infections, cold, fatigue and stress; heals wounds and burns.	Citrus fruits, berries, green and leafy vegetables, tomatoes, cauliflower, amla, orange
D	Promotes bone and tooth development and normal growth; helps utilization of phosphorus and calcium; maintains nervous system and functioning of heart, prevents rickets.	Egg yolk, milk, Exposure to the sun light enables the body to make its own Vitamin D
E	Protects body's store of vitamin-A, strengthens capillary walls; regulates menstrual rhythm; prevents loss of other vitamins; helps blood flow to heart; lowers blood cholesterol and fatty acids; vital to cell health; regulates protein and calcium metabolism	Soyabeans, vegetable oils, sprouts, leafy greens, enriched flour, whole wheat, wheat germ, whole grain cereals, eggs.
K	Helps in clotting of blood, assists in the synthesis of proteins	Green vegetables, liver, egg yolk; also synthesised by intestinal bacteria.

Minerals in our diet

Our diet should essentially contain several minerals including calcium, iron, sodium, phosphorus, zinc and iodine. Each of these minerals play various roles in the functioning of our body. For instance, calcium helps to build bones and teeth; helps in the proper functioning of muscles, heart and nerves; relieves pain and cramps; helps in clotting of blood. Dairy products, soyabeans, Ragi, sunflower seeds and legumes are rich in calcium.

Sodium helps to control blood pressure, regulates the function of muscles and nerves. Our food invariably contains the required amount of sodium.

Phosphorus is required for the formation of bones and teeth. It is involved in metabolism of carbohydrates, fats and proteins. Phosphorus is abundant in milk, milk products, whole grains, etc.

Iron is another important mineral. It is a constituent of haemoglobin which plays an important role in oxygen transport. Liver, meat, oysters, oat meal, nuts, beans, wheat germ and greens contain iron.

Iodine helps in the secretion of thyroxine from thyroid gland. It prevents goitre. It helps to burn fat; converts beta-carotene into vitamin A; regulates energy production in our body and maintains hair, nails, skin and teeth. Seafoods and vegetables are good source of iodine.

Zinc in our diet helps to reduce cholesterol deposits; helps in making enzymes and insulin; supports metabolism of carbohydrates; facilitates the proper functioning of prostate gland. Eggs, cheese, beef, pork, wheat germ, brewer's yeast and pumpkin seeds are some of the good sources of zinc.

Potassium is a mineral that helps to regulate fluid balance in our body. We also need it for the proper functioning of nerves and muscles. Peanuts, bananas, green beans, mushrooms and oranges are a few good sources of potassium.

Activity 18.4

What other minerals are essential to our body? Find out the sources and functions of each of those minerals. Represent the data collected in a suitable table.

Functions and principal sources of roughages

Roughage foods are foods which have high fibre content. The sources which are rich in dietary fibre are fruits, vegetables and greens. These are also a good source of vitamins, minerals and other useful substances. Whole grains also provide roughage. Dietary fibre is important because it adds to the volume of food. This facilitates easy movement of materials in the alimentary canal. When the amount of roughage is less the movement in the large intestine and bowel movement become difficult.

This is because too much of water is absorbed from the undigested food. Hence, the undigested food becomes relatively dry and hard. This results in constipation. To prevent this, it is important to increase the volume of the roughage in our diet.

History of dietary fibres: The word 'Fibre' gained importance in 1970s by Dr. Denis Burkitt. He made a hypothesis that dietary fibre can prevent certain diseases. He and his colleagues made a study on dietary contents in Africa. They discovered that Africans did not suffer from certain diseases that are common in Western cultures. For example, diabetes, high blood pressure, obesity, gallstones, intestinal problems, colon cancer etc were rare in African cultures. They attributed this to high intake of dietary fibre and low intake of refined carbohydrates. They also noted the emergence of such diseases in the west after 1890. This followed the introduction of a new milling technique that removed fibre from whole grain flour. Rightfully Dr. Denis Burkitt was nicknamed as the 'Fibre man'.

Activity 18.5

Make a list of food items you eat that are rich in fibres.

Functions of water in our body : Water is essential for the human body. The human body can last weeks without food but not without water. Water constitutes about 55–75 per cent of our body mass. The prominent constituent of blood, digestive juices, urine and perspiration is water. The body cannot store water and must have fresh supply every day to facilitate metabolic processes. We also need fresh supply of water to make up for losses from lungs, skin, urine and faeces. The amount we need depends on our metabolism, the weather, the food we eat and our activity levels.

Water helps to maintain the health of every cell in the body. It keeps the blood thin enough to flow through blood vessels. It helps to eliminate the wastes and excess materials. Water regulates body temperature through sweating. It keeps mucous membranes, lungs and mouth in moist conditions. Water helps digestion and prevents constipation. It improves the texture of skin and its appearance. It helps to carry nutrients and oxygen to the cells. It serves as a shock absorber inside

the eyes, spinal cord and in the amniotic sac surrounding the foetus in pregnancy. If you do not drink enough water regularly, there is increased risk of kidney stones, dehydration, urinary tract infections. Babies and elders are vulnerable to dehydration. How can we avoid this? One must increase water intake. Symptoms of dehydration include headache, lethargy, dry or cracked lips, dark-coloured urine and physical weakness. Eventually urination stops, the kidneys fail and the body cannot remove toxic waste products. In extreme cases, this may result in death. Diarrhoea, vomiting, or both are the common causes of dehydration.

What should one do if a person is showing symptoms of dehydration? You must have heard of Oral Rehydration Solution (**ORS).** It is a solution of common salt and sugar in potable water. Prescriptions from the ancient Indian physician **Sushruta** date back to over 2500 years with treatment of acute diarrhoea with rice water, coconut juice, and carrot soup. However, this knowledge was not carried over to the Western world. Many people died due to dehydration until the **"Oral Rehydration Therapy"** became popular. In the late 1950s, **Dr. Hemendra Nath Chatterjee** in India prescribed ORS for cholera patients and achieved good results.

Activity 18.6

You can prepare ORS at home. Take one litre of potable water in a clean vessel. Add one teaspoonful table salt and six teaspoonfuls of common sugar. Give this in plenty to a person with dehydration. Ready packets of ORS prepared as per the guidelines of WHO are available in market. They may contain glucose, potassium chloride and trisodium citrate.

Think : An intake of 8-10 glasses of water a day is recommended However, some people drink in small quantities. Is it correct ?

Tests for major constituents of food

Now you may be curious to know the principal nutrient present in a

particular food item. There are some simple tests to detect the nutrient in a given food. Take the help of your teachers.

Simple tests for carbohydrates

Test for glucose: As you know, glucose is a simple carbohydrate. To test the presence of glucose, you need a solution called Benedict's reagent. It is a blue coloured solution of copper sulphate, sodium hydroxide, and tartaric acid. It is available in a chemist's shop. You also need a spirit lamp and a test tube holder.

Dissolve a pinch of glucose in about 5 mL water taken in a test tube. Add about 5-6 drops of Benedict's reagent and heat for about two minutes. Note the change in colour if any. Appearance of a brick red precipitate indicates the presence of glucose. Why do you get the brick red precipitate?

If the sample solution contains traces of glucose, green to yellow colour appears. If moderate amount of glucose is present, colour of Benedict's reagent turns orange red.

Test for starch: Starch is a complex carbohydrate. To test for the presence of starch, you need iodine solution. This is available in a chemist's shop. Take a small quantity of the given food stuff in a dish. Add 2-3 drops of iodine solution. Note the colour change if any. The appearance of a blue-black colour indicates the presence of starch.

Simple test for proteins

Biuret test : You need Biuret reagent to conduct this test. It is a bluish solution containing sodium hydroxide and a small amount of copper sulphate.

Take about 5 mL of the solution in a test tube. Add 5-6 drops of biuret reagent. Wait for a while. Do not heat. A colour change from blue to violet or purple indicates the presence of protein in the solution.

Simple test for lipids

Emulsion test for fats and oils: Emulsion is a mixture of two liquids

which do not mix with one another. It is a suspension of one liquid in another. Take a few groundnut seeds. Crush well and take them in a test tube. Add a small amount of ethyl alcohol to it. Shake well. Heat the test tube carefully in a waterbath. Do not directly heat on a flame because alcohol is flammable. When the substance dissolves in alcohol, filter or dilute until you obtain a clear liquid.

Take a small quantity of tap water in another test tube. Slowly pour the solution prepared above into the test tube. A whitish suspension indicates the presence of fat or oil.

We have studied in this chapter many aspects of food. A balanced healthy diet is one that provides all the nutrients to our body in right proportions. We all need a daily intake of a variety of nutrients like carbohydrates, proteins, fats, vitamins, minerals, and dietary fibre to maintain normal health. We need these nutrients in varying proportions. Taking a balanced food will prevent many diseases and keeps our body healthy and active. You will study more about food nutrients in higher classes.

You have learnt

- The importance of food.
- The major constituents of food.
- The importance of each of the major constituents of food.
- The classification of food into various groups based on its predominant constituents.
- Examples for food rich in carbohydrates, fats and proteins.
- The importance of roughage and water in our food.
- Simple tests to detect the major constituents of food.
- Appreciate the importance of balanced diet.

EXERCISES

I. Four altertnatives are given to each of the following incomplete statements / questions. Choose the right answer:

1. The major metal present in bones is

   a. sodium b. iron c. calcium d. phosphorus

2. Children like to eat bakery items and chocolates. Elders advise them to eat vegetables also, and not to keep aside curry leaves while eating food items. This shows the importance of

   a. carbohydrates b. fats c. proteins d. lipids

3. A green leaf that has fallen down from a plant is taken and is kept in water for sometime and then taken out; It is then dipped in spirit and iodine solution. The leaf turns bluish indicating the presence of

   a. starch b. oil c. protein d. fibre.

II. Fill in the blanks with suitable words :

1. Emulsion test is conducted to detect _____.
2. Fat soluble vitamins are A, D, E and _____.
3. Amino acids contain the elements carbon, hydrogen, oxygen and _____.
4. The Haemoglobin responsible for transport of oxygen to the different parts of the body contains the metal _____.
5. Biuret solution contains sodium hydroxide and _____.

III. Match the following :

A	B
1. Haemoglobin	a. Prevents night blindness
2. Vitamin C	b. clotting of blood
3. Vitamin A	c. heals wounds
4. Vitamin K	d. oxygen carrier
	e. helps in digestion
	f. improves immunity system
	g. develops muscles

IV. Answer the following :

1. Why should we have variety in our diet?
2. List four major sources of carbohydrates for the people in your region.
3. What food items containing lipids do people in your region consume?
4. List the nutritional importance of proteins.
5. Why do some people suffer from nutritional deficiencies despite having enough food?
6. Explain the importance of water in our diet.
7. A beaker contains a thick liquid. How do you test whether it is a lipid?
8. What is the function of calcium in our body?
9. List all the major classes of ingredients that should be present in balanced diet.
10. Make a list of food items that are rich in dietary fibres.

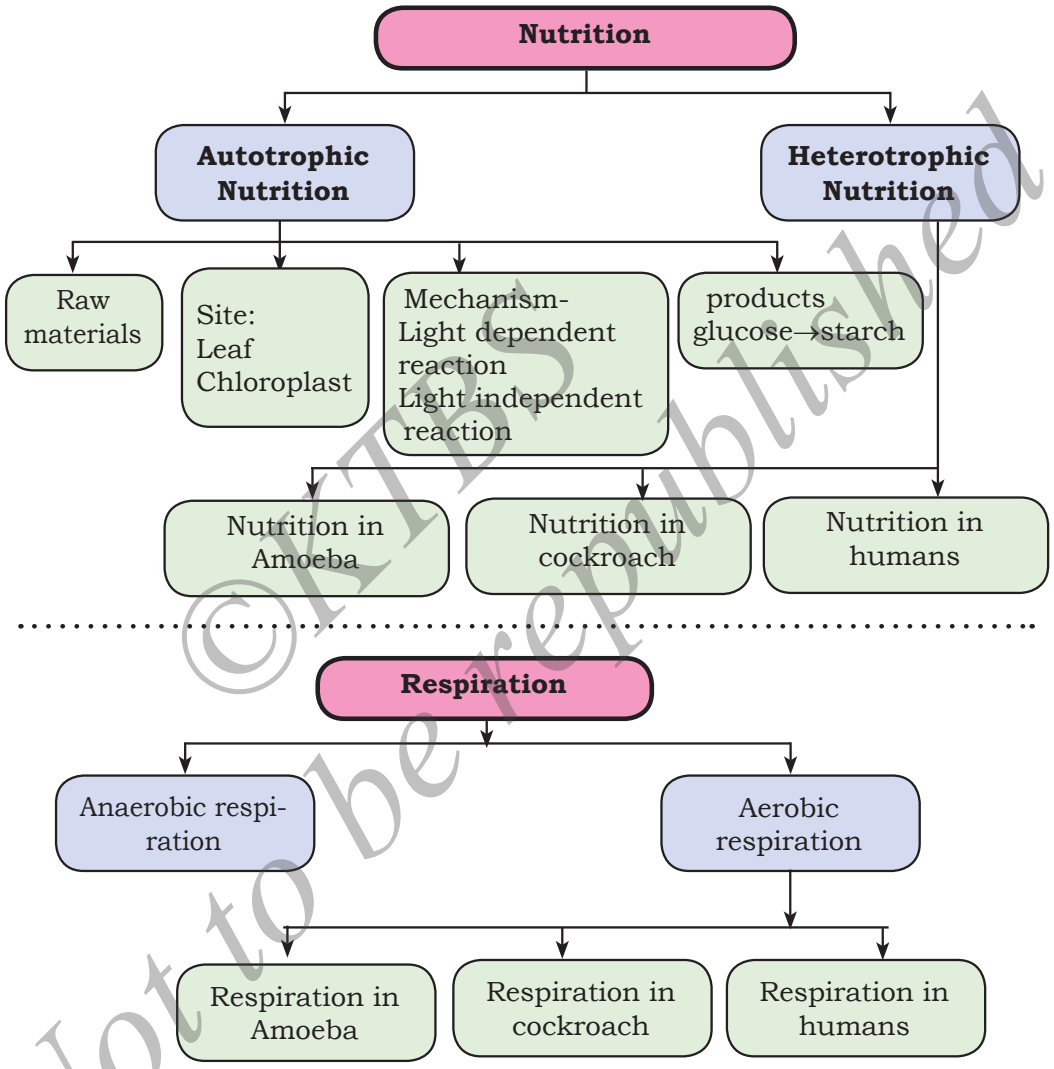
Think :

1. Why do children both in rich and poor families suffer from nutritional deficiencies? What are your suggestions to improve the situation?
2. How does lack of nutrition affect your activities, studies and personality? How can you prevent it?
3. What dietary changes at your home will improve the nutritional status of your family members?

★★★★★

CHAPTER 19

NUTRITION AND RESPIRATION



You have seen many types of living beings around you, from tiny insects to bulky trees and animals. If these living beings are to survive many life activities should take place in them. Plants and animals look very different. Yet, they have certain life activities in common. They are respiration, nutrition, growth, movement, response to stimuli, excretion and reproduction. These are called **life processes**. These life processes keep them alive. In this chapter, let us study two of the life processes **nutrition** and **respiration.**

Nutrition :

The process by which organisms obtain and utilise food is called nutrition.

There are two major modes of nutrition : i) Autotrophic nutrition ii) Heterotrophic nutrition.

Autotrophic nutrition:

All organisms require food. Why is food essential? Where do organisms get food from? You have already learnt that, some organisms can prepare their own food. Such organisms are called autotrophs. All green plants are autotrophs. Green plants prepare their food by a process called photosynthesis.This mode of nutrition is called autrotrophic nutrition.

Activity 19.1

Sow a few bean / ragi seeds in two separate pots. Allow the seeds to germinate. Shift one of the pots which contains plants to a dark room, and the other pot to a well lit and ventilated room. Observe the plants in the pots after about 48 hours. What is your conclusion?

Know this :
Photo means Light, Synthesis means Preparing or putting together

Photosynthesis is a chemical reaction. Like in any of the other chemical reaction there will be reactants and products in photosynthesis also. What are the raw materials required for photosynthesis? Let us explore this with the help of the following experiment.

Experiment to show that carbon dioxide is necessary for photosynthsis. Take two potted plants which are kept in a dark room for two days. Mark one of the pots as 'A' and the other as 'B'. Place a beaker containing potassium hydroxide solution near the plant 'A' and a beaker containing sodium bicarbonate solution near the plant 'B'. Cover both the pots separately by bell jars or polythene bags as shown in the figure19.1. Take precautions such that air does not enter the polythene bags. Place both the potted plants side by side in a well lit room for about 48 hours. Test a few leaves of both the plants for starch. What inference will you draw?

Note : Take the help of your teacher for testing the leaves for starch.

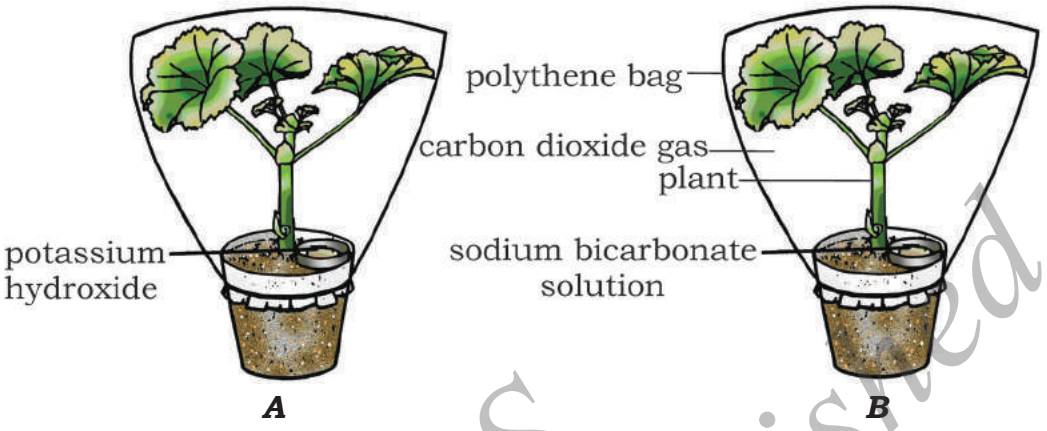


Fig. 19.1 Experiment to show that carbon dioxide is necessary for photosynthesis

Think : Why should the potted plants be kept in a dark room for about 48 hours before the experiment?

What is the role of potassium hydroxide and sodium bicarbonate?

From the above experiment you would conclude that carbon dioxide is required for plants to prepare food in the form of starch. Is carbon dioxide the only raw material used by the plants for photosynthesis? No, they also require water.

Think: A few students are walking in a garden next to a busy main road. They collect a few leaves from a plant in the garden. They observe a dusty layer on the surface of the leaves. Will the dusty layer present on the surface of leaf affect food production?

You have already learnt that, roots absorb water and mineral nutrients from the soil. How does carbon dioxide enter the plant body? We shall find the answer by conducting the following activity.

Activity 19.2

Cut a thin cross section of Nerium leaf. Place the section in a petridish containing water. Place this leaf section on a slide. Add a drop of water and cover the specimen with the help of a cover slip. Observe the minute openings on the surface of the leaf under the microscope.

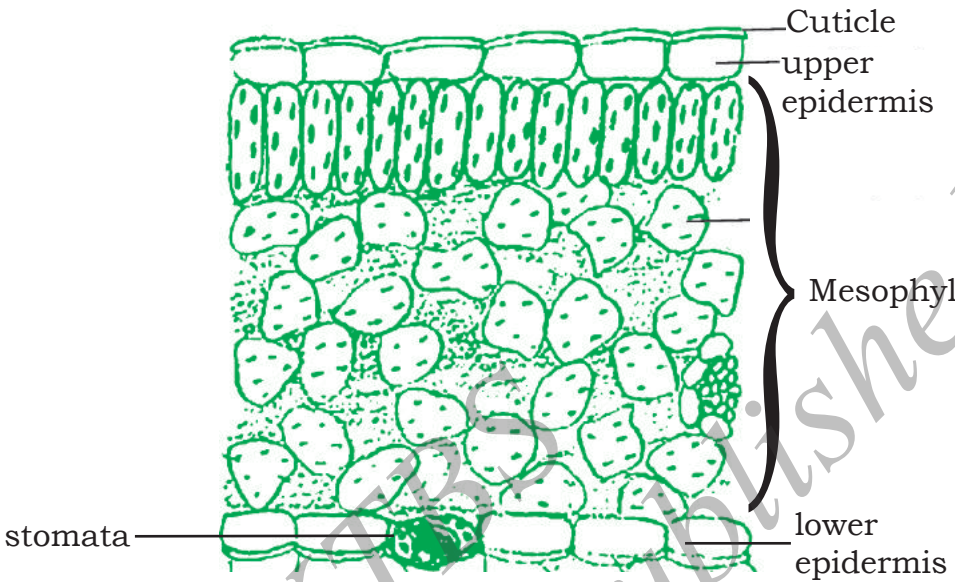


Fig. 19.2 Section through a dicot leaf

The minute openings which you have observed are called **stomata.** Carbon dioxide enters the plant body through stomata.

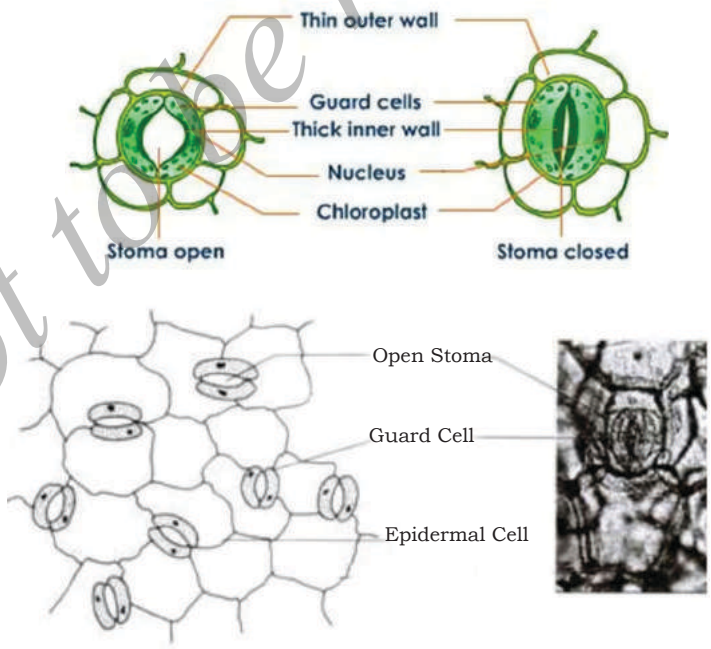


Fig. 19.3 Structure of Stomata

Apart from starch, oxygen is also a product of photosynthesis. Let us examine this with the help of the following experiment.

Experiment to Show that oxygen is released during Photosynthesis.

Take two beakers filled with water. Add a few crystals of sodium bicarbonate to both beakers. Place *Hydrilla* plants in both the beakers and invert large funnels over them. Take two test tubes. Place small pieces of steel wool at the bottom. Fill them with water and invert them over the stem of each funnel. Place one of the beakers in a bright sunny area and the other in a dark place for about 48 hours.

Observe the colour of the steel wool. Why does it turn brown?

Test the gas collected in the test tubes by introducing burning splinters. What is your inference?

Fig. 19.4 Experiment to show that oxygen is liberated during photosynthesis

As stated earlier, photosynthesis is a chemical reaction. It can be represented with the help of an equation.

$$\text{Carbon dioxide + water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose + oxygen + water}$$

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Glucose produced during photosynthesis is stored in the form of starch.

Where does photosynthesis take place in leaves? Already you have learnt about an organelle called chloroplast. Photosynthesis takes place in the chloroplast.

For better understanding of photosynthetic process, it is important to recall the structure of chloroplast. As you are aware there are two major regions called **grana** and **stroma** in the chloroplast. These two regions are involved in two different phases of photosynthesis called light dependent reaction which is also called **Light reaction** and light independent reaction, which is also called **Dark reaction.**

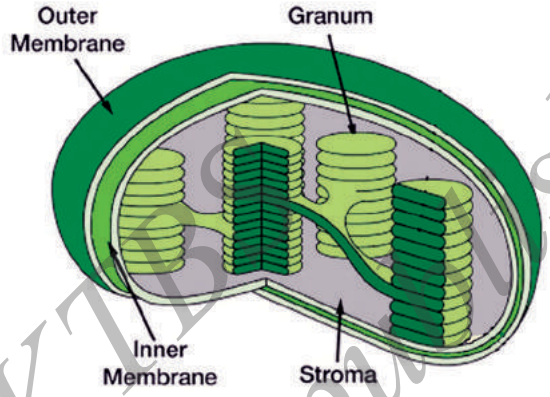


Fig. 19.5 Structure of chloroplast

Light dependent reaction: Light dependent reaction takes place in the presence of sunlight, in the grana region. During this reaction water is decomposed into hydroxyl (OH^-)and hydrogen (H^+)ions in the presence of light energy. Oxygen is given out by plants in this phase. Light energy is converted in to chemical energy and is stored in the form of ATP. What is the use of chemical energy that is released during light reaction? This energy is used to prepare starch during light independent reaction.

Light Independent Reaction: In this reaction, carbon dioxide is reduced to starch, utilizing the energy released during light dependent reaction. This reaction takes place in the stroma region.

Note : Many times it is wrongly believed that light independent reaction takes place only during night times.

By now you are able to differentiate between the two phases of photosynthesis. What if sun would not have been present?

When soil is poor in nitrogen, plants try to obtain nitrogen by other means. Here is a group of photosynthetic plants which obtain nitrogen by trapping and digesting insects. Such plants are called **insectivorous plants.** Example – **Drosera, Nepenthes.**

Fig. 19.6 Nepenthes

Fig. 19.7 Drosera

Think : Can other common plants grow in areas where lots of insectivorous plants grow?

You might have seen some plants growing on trees. These plants capable of photosynthesis take support on the host tree. Such plants are called **epiphytes**. Example – Orchids.

Fig 19.8 Orchid, an epiphyte

Think : How do orchids absorb water?

Heterotrophic Nutrition :

Can animals prepare their own food? Not only animals but also fungi and some bacteria cannot prepare their food. These organisms are called **heterotrophs.** Their mode of nutrition is called **heterotrophic nutrition.**

You might have seen compost heaps in your village. Compost obtained by the decomposition of organic matter is an excellent nutrient supplement to agricultural fields. How does this decomposition take place? Thanks to fungi and bacteria which feed on organic matter by decomposing the same. Hence bacteria and fungi are called **saprophytes**.

Think : What would happen if there were no saprophytes?

Will moulds grow on slices of bread kept in a refrigerator?

Have you ever been advised deworming by a doctor? You might have heard or seen worms being eliminated in the faeces. Where were these worms? From where would these worms get nutrition?

These worms are in the intestine. They take shelter and nutrition from the host. But they are of no use to the host. Such worms are called **parasites**. Many times they are found to be harmful and fatal also.

Find out : Are head lice parasites? How can we get rid off their menace?

There are mutually beneficial organisms. You might have heard of bacteria called ***Escherichia.coli*** present in our large intestine. What would happen if they were not present? Then we should have been taking B-Complex tablets and injections regularly. These *E.coli* bacteria take shelter and nutrition from us and in return provide us the vital B-complex vitamins. Here both humans and the bacteria are mutually benefitted. The mode of nutrition observed in ***E.coli*** bacteria is called **mutualism**. This is also called **symbiosis**. Other examples of mutualism are

1) Rhizobium bacteria in the root modules of leguminous plants.

2) Egret on the back of cattle

Fig.19.9 A Root nodules with Rhizobium bacteria

Fig.19.9 B Egret on the back of cattle

Activity 19.3

Collect some more examples for mutualism.

Nutrition in animals

You already know that animals are heterotrophs. The type of nutrition found in animals is called **holozoic.** Holozoic nutrition involves five steps.

a. ingestion
b. digestion
c. absorption
d. assimilation
e. egestion

ingestion → digestion → egestion
↓
absorption
↓
assimilation

Animals take in food by a process called **ingestion**. The food that enters the animal's body should be broken into simple usable forms. This is done by a process called **digestion**. Food is converted to simple usable form by mechanical and also chemical process. Mechanically food is crushed by teeth. Chemically food is digested with the help of digestive enzymes. Digested food is directly taken into the cytoplasm in lower animals such as Amoeba. In higher animals such as human

beings digested food is absorbed and transported to cells and tissues through blood. This process is called **absorption**. Digested food is stored or utilized in the cells. This happens by a process called **assimilation.** The undigested food particles are eliminated from the animal body by a process called **egestion.**

You know that there are different types of animals. Are nutrition and digestion similar in all animals? Let us find out by taking the examples of amoeba, cockroach and human being.

Nutrition in Amoeba

As you are aware, amoeba is unicellular. All life activities take place in the same cell. Amoeba feeds on bacteria, diatoms, unicellular algae, minute protozoa and zooplankton. Hence it is an **omnivore**.

Look at the Fig. 19.10

Observe how the pseudopodium is surrounding the prey and ingesting it.

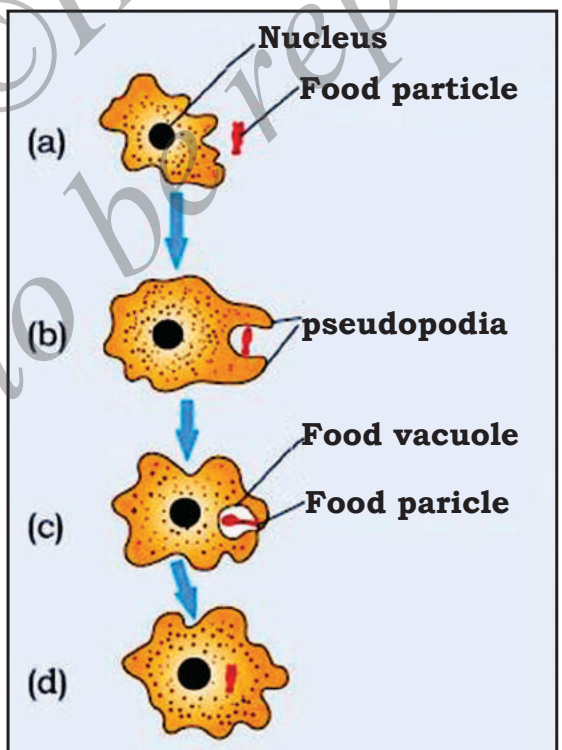


Fig 19.10 Nutrition in amoeba

The ingested prey enters the food vacuole where digestion takes place. Digestive enzymes such as amylase and protease are provided by the lysosome. Amylase converts complex carbohydrates into simple sugars. Protease converts proteins into amino acids. Digested food is diffused into the cytoplasm from the food vacuole. Cytoplasm is circulated through out the cell, so that all parts of the cell receive nutrients. Digested food is used for all its life activities. Undigested food is egested out.

Nutrition in Cockroach :

Cockroach is a common house pest found in dark corners of kitchens and store rooms. What does it eat? How can it identify its food? It eats varieties of materials like rubber, pieces of pencil, paper, coconut, cloth and green chillies. Cockroach feeds on almost everything!

Look at the figure 19.11. Observe a pair of feelers in the head region. These are called **antennae**. Antennae sense the food. Food is crushed in the mouth, by mandibles (teeth- like).

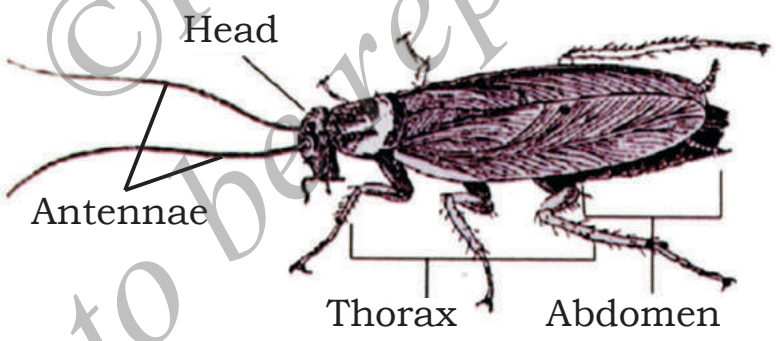


Fig. 19.11 Cockroach

Find out : The mouth parts of cockroach which help in crushing the food.

Activity 19.4

Observe the feeding habit of butterfly. Collect more information. Discuss with your friends and teachers.

Digestive system of cockroach consists of alimentary canal and digestive glands. Alimentary canal includes three parts. They are foregut, midgut, hindgut. Study the various parts and their functions given in the following table.

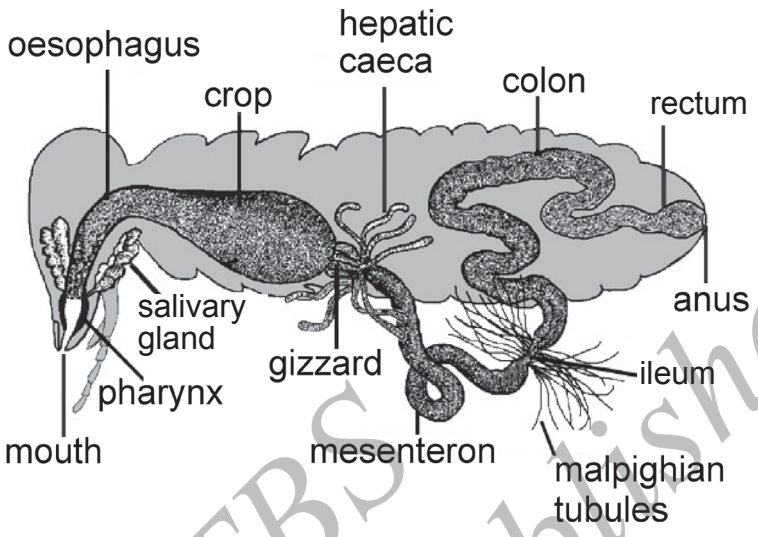


Fig. 19.12 Digestive system of cockroach

Table 19.1 Cockroach: Parts and functions of digestive system.

Parts of alimentary canal	Functions
Foregut	
• Mouth	Food is crushed and lubricated. Salivary amylase converts starch into maltose.
• Oesophagus	Food pipe pushes this food into crop.
• Crop	Food is stored for a short time.
• Gizzard	Grinds the food.
Midgut	
	It is the major site of chemical digestion.
	Amylase converts starch into maltose.
	Maltase converts maltose into glucose.
	Protease helps in the digestion of proteins.
	Lipase helps in the digestion of lipids.
	Digested food is absorbed and stored. It is transported to various parts.
Hindgut	
• Rectum	Reabsorption of water from undigested food
• Anus	Excretion of undigested food.

Think : what is the need for reabsorption of water from the undigested food in the hind gut of cockroach ? Try to find the answer.

Nutrition in Man :

Let us now learn how digestion process occurs in human alimentary canal. Human digestive system is much more complex than the digestive system of cockroach.

Alimentary Canal

The alimentary canal includes the mouth, pharynx, oesophagus, stomach, small intestine, large intestine and anus.

Think : Are human beings omnivores?
Why do human beings prefer eating cooked food?
What might happen if we consume only raw food?

The ingested food is subjected to mechanical breakdown in mouth. Food is chewed with the help of teeth and tongue. Saliva makes food into a soft paste called **bolus**. Saliva contains salivary amylase which converts starch into maltose.

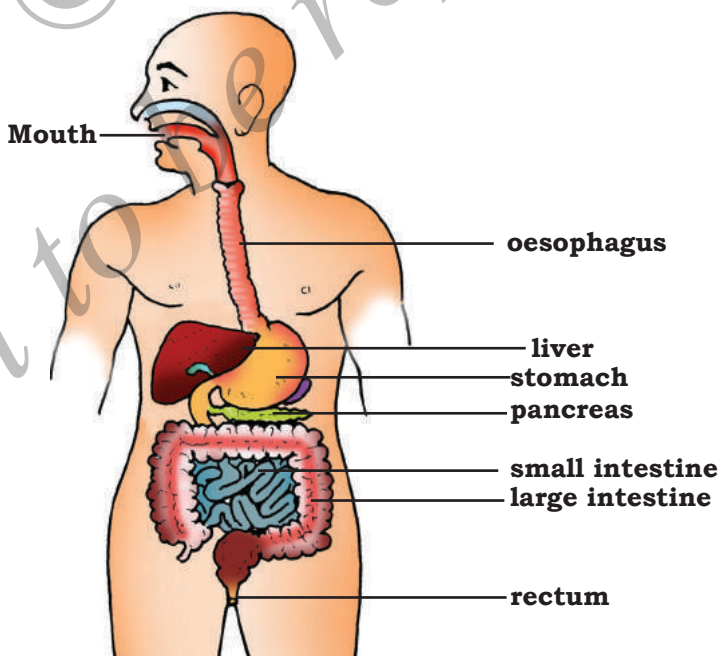


Fig. 19.13 Human digestive system

Activity 19.5

Chew a small amount of pounded rice (ಅವಲಕ್ಕಿ) for 10 minutes. How does it taste? Why? Try this at home.

Bolus is swallowed into the stomach via pharynx and oesophagus (food pipe). Pharynx is the common passage for both food and air. During swallowing the food, entry of food into the windpipe is prevented by epiglottis, a lid.

Think : What might happen if there is an accidental entry of food into wind pipe? Why do we get hiccups ?

The movemet of bolus through the oesophagus to the stomach is by the rhythmic contraction and relaxation of the muscles. This process is called **Peristalsis**.

Think : Oesophagus has no role in digestion. Why?

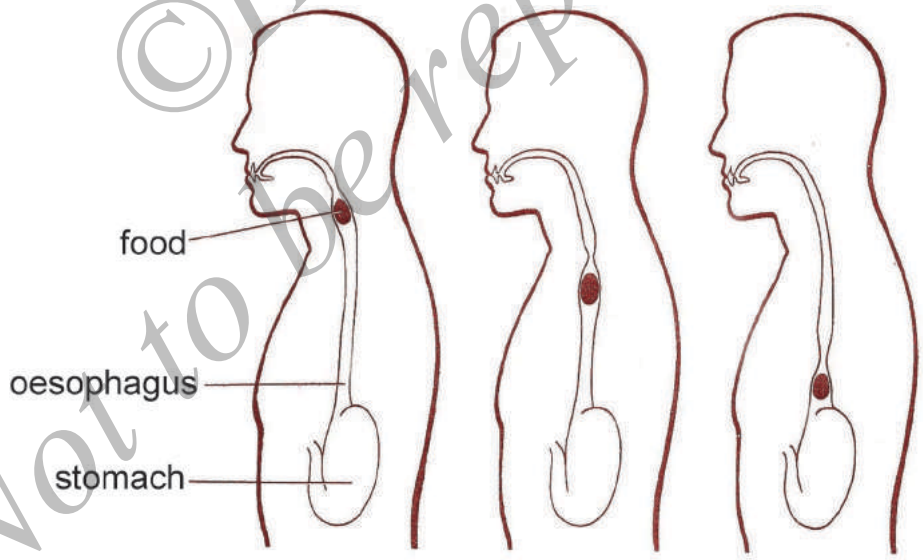


Fig. 19.14 Peristalsis

Activity to demonstrate action of salivary amylase on starch.

- Take 1 ml starch solution (Ganji) in two test tubes. Label them as A and B.

- Add about 1 ml saliva to test tube 'A'.
- Leave both test tubes undisturbed for about half an hour.
- After half an hour add a few drops of iodine solution to both test tubes.

What do you observe? What is your inference? Which test tube responds to iodine test?

This is the reason why pounded rice becomes sweet. Now correlate both the activities.

Bolus which enters the stomach is stored for some time. Stomach secretes gastric juice which contains **hydrochloric acid**. This hydrochloric acid kills the microbes that may have entered through food and water. What would happen if too much of acid is secreted? Is there any other use from the acid secretion? Digestive enzymes such as **pepsin** and **rennin** are also secreted in the stomach. Pepsin converts proteins into polypeptides. Rennin converts milk into curd. At this stage, semi liquid food is called **'chyme'**. Chyme enters the small intestine, where digestion continues further.

Bile juice, pancreatic juice and intestinal juice act upon chyme and digest the food further. Bile juice is produced by the liver and is stored in the gall bladder. Pancreatic juice is produced in the pancreas where as intestinal juice is produced in the intestine. Bile juice emulsifies fats. Pancreatic juice contains protease, amylase and lipase enzymes. Amylase converts starch into maltose, protease breaks polypeptides into smaller peptides. whereas lipase converts complex fats to simple fats. Intestinal juice contains maltase, sucrase, lactase, peptidase and lipase. Maltase converts maltose to glucose. Sucrase converts sucrose to glucose. Lactase converts lactose to glucose and peptidase converts peptides to amino acids. Digested food is absorbed by the finger like projections of the small intestine called **villi**. This digested food is circulated to all parts of the body with the help of circulatory system. You will be learning about circulatory system in your later classes.

Undigested food is passed on to the large intestine. There is reabsorption of excess water and minerals from the undigested food. After this, it is called faeces. Faeces is eliminated through the anus.

Word help: Emulsification- Breaking down of large masses of fat into smaller masses.

Find out: If a person eats a lot junk food, he experiences difficulty in passing out faeces. What suggestion would you like to give him to overcome this problem? List out other digestive disorders and also suggest remedies to overcome those disorders.
Note : Refer chapter 18 in your science text book. You may get some ideas to help him overcome this problem.

Table 19.2

Observe the following table to understand the digestion process in humans

Sl. No.	Parts of alimentary canal	Glands and juices secreted	Enzyme secreted and its functions.
1.	Mouth	Salivary Glands - Saliva	Salivary amylase: converts starch into maltose
2.	Oesophagus	----	No enzymes are found. Peristalsis pushes the food into stomach.
3.	Stomach	Gastric glands - gastric juice	i) Pepsin - converts complex proteins into simple proteins. ii) Rennin: converts milk into curd. Stomach also secretes 'HCl' which kills bacteria and provides acidic medium for pepsin.
4.	Duodeum (Upper small intestine)	Liver - bile juice Pancreas - Pancreatic juice	No enzymes in bile juice. Bile emulsifies fats. i) Pancreatic amylase converts starch into maltose. ii) Lipase converts emulsified fats into fatty acids and glycerol. iii) Trypsin converts proteins into polypeptides

5.	Lower parts of small intestine (Jejunum and ileum)	Intestinal juice	i) Maltase converts maltose into glucose. ii) Sucrase converts sucrose into glucose and fructose iii) Lactase converts lactose into glucose and galactose. iv) Peptidase converts peptides into amino acids.
6.	Large intestine (Colon)		Colon absorbs water and minerals from undigested food.
7.	Rectum		Temporarily stores undigested food
8.	Anus		Excretes undigested food

Respiration

You know that energy is required to do work. Where do we get the energy from? In what form will that energy be present? The answers for these questions can be known with the help of the following example.

After having completed a 400*m* running race, an athlete feels fatigue. He/She is given one or two spoons of glucose powder. After consuming glucose he/she regains energy. This implies that energy is released from glucose. You may recall that complex carbohydrates get converted to glucose in digestion process. Glucose on reaching the cells reacts with oxygen to liberate energy. This process is called **respiration**.

Like photosynthesis, respiration is also a chemical reaction. The release of energy from food may or may not utilize oxygen. If oxygen is used to break the food for energy liberation then it is called **Aerobic respiration**. If oxygen is not used for the release of energy, it is called **Anaerobic respiration**. They can be represented with the help of following equations.

Aerobic Respiration

Glucose + Oxygen → Carbon dioxide + Water + Energy

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Energy

Anaerobic Respiration

Glucose → Ethyl Alcohol + Carbon dioxide + Energy

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ + Energy

Activity 19.6

Observe the above equations and write the differences between aerobic and anaerobic respiration.

Find out : *Prokaryotes do not contain mitochondria. How is energy released in them?*

Respiration in Amoeba, Cockroach and human beings

Respiration in Amoeba takes place by diffusion through body surface. Cockroach has a separate respiratory system called **tracheal system.**

The tracheal system includes **Trachea, Tracheoles and Spiracles.** There are ten pairs of respiratory openings called **spiracles** on the lateral side of the body. Two pairs are present in the thoracic region and eight pairs are in the abdominal region.

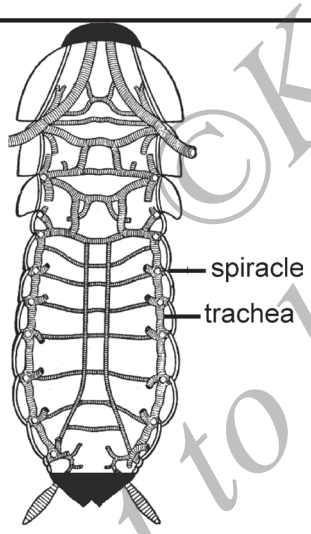


Fig. 19.15 Respiratory system of cockroach

Tubular trachea and tracheoles carry oxygen from the diffused air to all parts of the body. Cells take in oxygen by diffusion and give out carbon dioxide to the tracheoles **Haemolymph,** the blood of cockroach, is involved in gaseous exchange between the cells. Carbon dioxide is diffused out of the body through the spiracles.

Find out : *How is respiration in cockroach more advanced than that of amoeba?*

Respiration in humans

Stand in front of a mirror, observe the chest movements as you take in and give out air. Taking in and giving out air is called **breathing.**

We breathe in and breathe out air with the help of respiratory system. Respiratory system consists of nose, pharynx, larynx, trachea, bronchi and lungs. Lungs include bronchioles and alveoli. Observe figure 19.16 and19.17 recognize the respiratory parts.

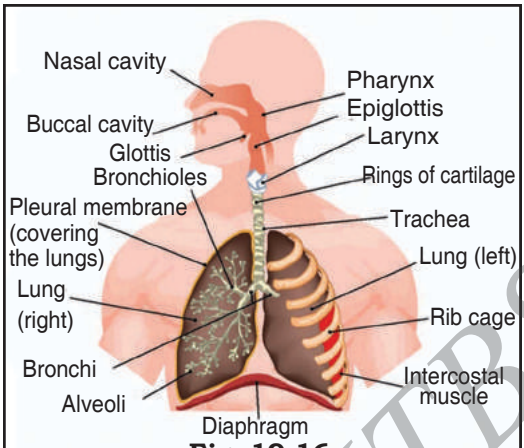


Fig. 19.16
Human respiratory system

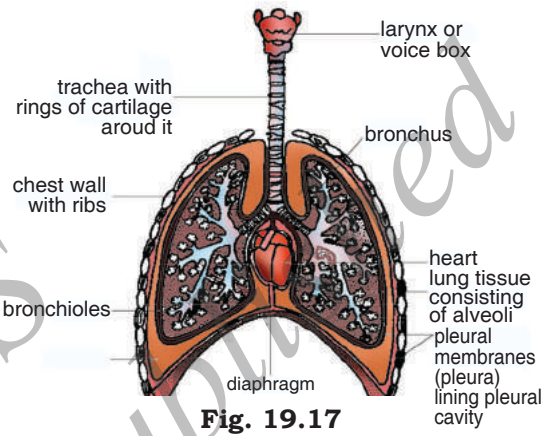


Fig. 19.17
Human lungs - internal structure

Air enters the nasal cavity through the **nostrils.** Dust particles present in the air are prevented from reaching the lungs.

Think : What special structures of nasal cavity prevent the dust particles present in the inhaled air?

A person in a dusty place often sneezes. Why?

Is it safe to breathe in air through mouth?

Air passes to the pharynx from where it is directed into the trachea with the help of **epiglottis**. Trachea is supported by 'C' cartilagenous rings which prevent trachea from collapsing. Trachea is divided into two branches called **bronchi**. One bronchus enters the left lung and the other enters the right lung. These bronchi are further branched into **bronchioles**. Air sacs are present at the terminals of bronchioles. These are called **alveoli**.

Blood circulating around the alveoli gives out carbon dioxide and collects oxygen. Oxygenated blood distributes oxygen to the cells. Oxygen is used for oxidizing glucose. This process is called **Cellular Respiration.** Carbon dioxide that is formed as a by product is carried by blood to the alveoli. This air is exhaled in the same pathway.

Activity 19.7 *To demonstrate the action of the diaphragm during breathing:*

Set up an experiment as shown in the fig. 19.18. The rubber sheet tied round the bottom mouth of a bell jar represents diaphragm, while balloons represents lungs. Pull the rubber sheet downwards. Pressure inside the bell jar is reduced and the balloons expand (breath in). When the sheet is pushed upwards pressure inside the jar is increased. This decreases size of balloons (breath out).

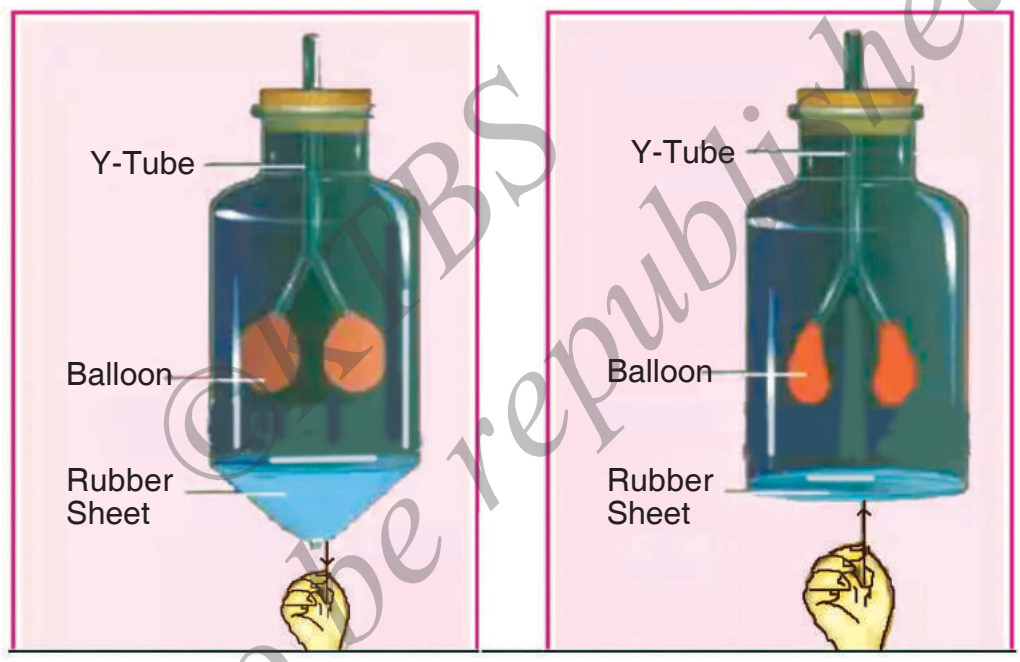


Fig. 19.18 Breathing mechanism

Did you know :

1. While at rest the body takes in and breathes out about 10 liters of air per minute.
2. The right lung is slightly larger than the left lung.
3. Right lung has three lobes whereas the left lung has only two lobes.
4. Surface area of lungs is roughly around the size of a tennis court.
5. An adult at rest usually breathes 12 to 15 times in a minute.

Activity 19.8

1) Find out yoga is essential to keep our body & mind fit & healthy How ?

2) Collect information about respiratory diseases.

You have learnt

- definition of life process.
- Plants need carbon dioxide for photosynthesis.
- The role of photosynthesis in bringing about biodiversity.
- Differentiation between light and dark reactions.
- The skill of preparing a Transverse section of leaf, root, stem.
- The role of microscope to understand better.
- The importance of being hygienic.
- the human diagestive system is more evolved than the digestive system of a cockroach.
- The process of respiration in cockroach and humans.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer:

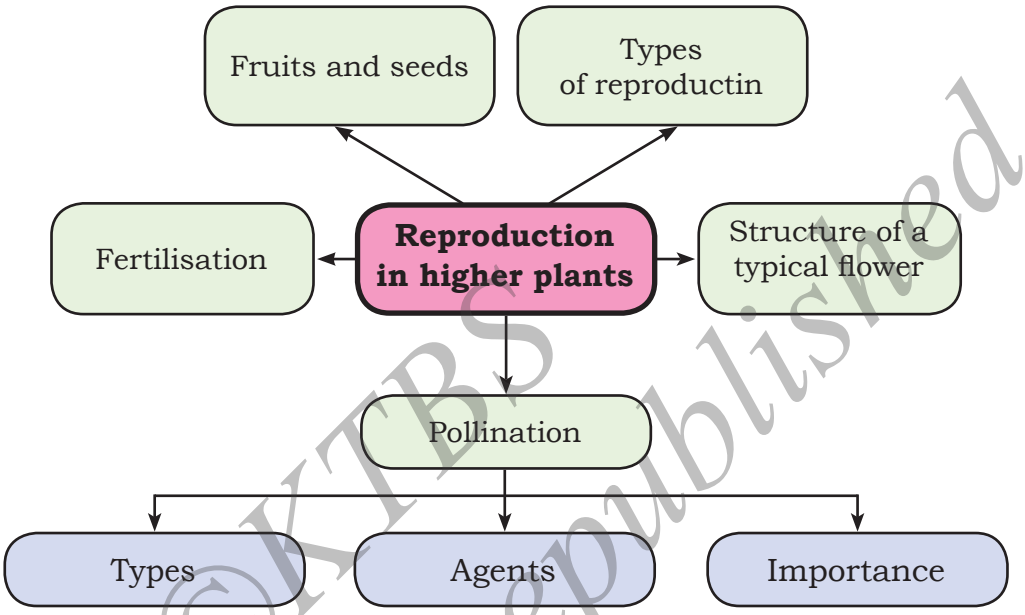
1. The process of obtaining food and utilizing it in the body is
   a. respiration b. nutrition c. excretion d. reproduction
2. One of these is a product of photosynthesis
   a. starch b. Fructose c. maltose d. sucrose
3. Insectivorous plants commonly grow in areas where soil is deficient in
   a. carbon b. nitrogen c. potassium d. phosphorus
4. A person applies hydrogen peroxide on his wound. This is to kill
   a. anaerobic bacteria b. aerobic bacteria c. fungi d. protozoa
5. Amylase converts starch to
   a. glucose b. sucrose c. lactose d. maltose

II. Answer the following:

1. What are life processes?
2. Explain the method of testing a leaf for starch.
3. Explain an experiment to demonstrate that oxygen is released during photosynthesis.
4. Differentiate between the two phases of photosynthesis.
5. What are parasites? Give two examples.
6. Amoeba cannot digest fats. Why?
7. Explain respiration in cockroach.
8. Explain respiration in human beings.
9. Draw a diagram of human digestive system and label the parts.

CHAPTER 20

REPRODUCTION IN HIGHER PLANTS



You are aware of the fact that reproduction is one of the basic characteristics of living organisms. Reproduction is absolutely necessary for the survival of any species.

You have learnt in your earlier classes that there are two basic types of reproduction – **asexual** and **sexual**. Lower organisms such as monerans, protistans, algae and fungi generally reproduce by asexual methods. Look at the examples like potato and sugarcane. The stem can give rise to new plants. Green plants exhibit vegetative and sexual reproduction.

Sexual reproduction involves the formation and fusion of specialized reproductive cells called **gametes**.

In this chapter you will study the process of sexual reproduction in the most advanced group of plants – the angiosperms, commonly called flowering plants.

Flower is the reproductive structure of a plant. Flower is a part of shoot system modified for the purpose of reproduction. Generally the flower arises from the axil of a leaf or from the apex of stem. The flower is generally borne on a stalk called **pedicel**.

Think : Are there plants which do not produce flowers? Then how do they reproduce?

Look at this Fig. 20.1 showing the parts of a typical flower.

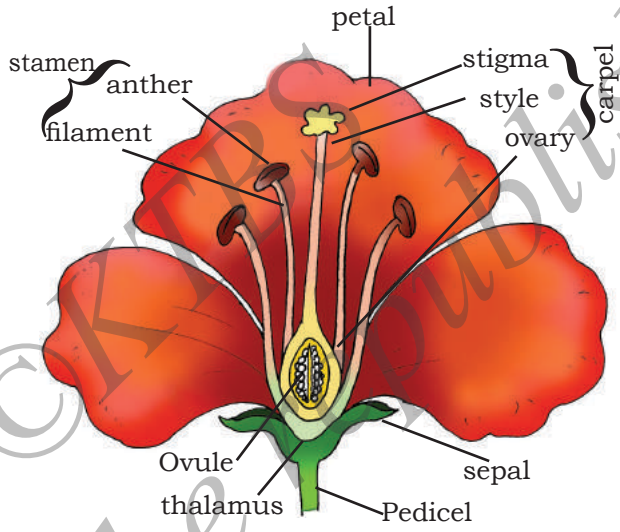


Fig. 20.1 Structure of a typical flower

You can see that the tip of the pedicel is enlarged to form a disc shaped **thalamus**. In the thalamus the different parts of the flower are arranged in four concentric whorls or circles. If you look from outside to inside, these whorls are calyx, corolla, androecium and gynoecium.

Calyx is the outermost whorl composed of green coloured units called **sepals**. They protect the inner parts of a flower in the bud condition.

Corolla is the second whorl from outside. It is composed of usually brightly coloured units called **petals.**

Androecium is the third whorl from outside. It is composed of male reproductive structures called **stamens**. Stamens produce pollen grains which contain male gametes.

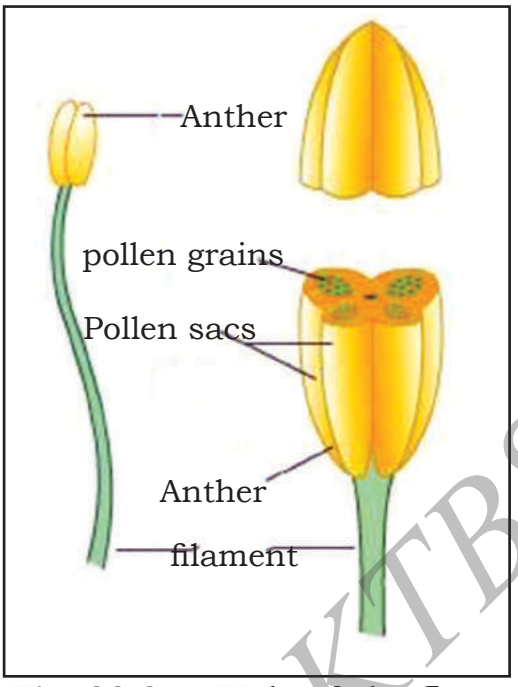


Fig. 20.2 A. Male of the flower stamen

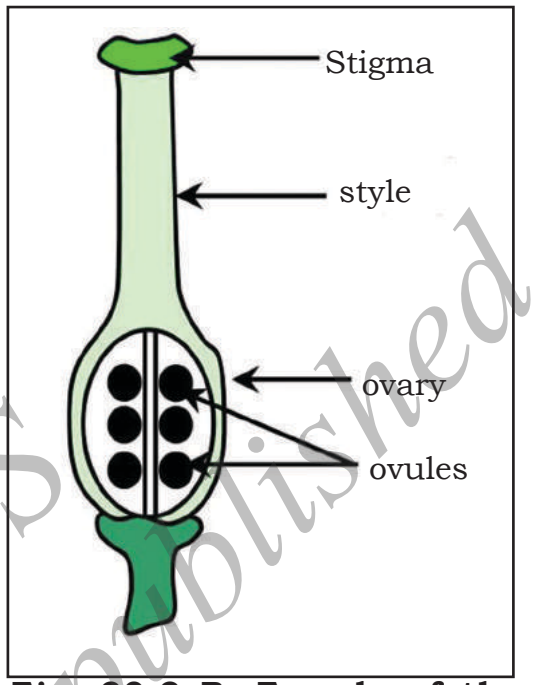


Fig. 20.2 B. Female of the flower

The innermost whorl is called **gynoecium**. It is composed of female reproductive structures called **carpels**. Each carpel has a basal swollen ovary, a middle elongated style and terminal sensitive region called **stigma**. Ovary encloses the **ovules** which contains female gametes-ova.

Activity 20.1

Collect a fresh hibiscus flower. Identify the stamens and the ovary. Place them in separate petridishes containing water. Split open the anthers of the stamen. Examine the anther with a hand lens. You will be able to see yellow coloured particles. These are the pollen grains. Cut open the ovary along its length. Using the hand lens observe whitish structures inside the ovary. These are the ovules.

In Angiosperms, process of sexual reproduction has three major events namely.

1. Gamete formation and gamete transfer
2. Fertilisation
3. development

1a. Gamete formation : It is the first process to occur during sexual reproduction. As you already kow, male gametes develop in stamens through the formatin of pollen grains. Similarly, female gametes (egg cells) develop inside the ovary of carpels.

1b. Pollination :

Once the gametes are formed, pollination occurs. The process of transfer of pollen grains from the anther to the stigma is called **pollination**. Pollination occurs with the help of agents like wind, water and animals. Pollination occurs in two ways-

1) Self pollination and 2) Cross pollination.

Observe the fig. 20.3 when pollen grains from the anther of a flower are transferred to the stigma of the same flower or another flower of the same plant. It is called **self-pollination**. If the pollen grains from one plant get transferred to the stigma of another flower in another plant of the same species, it is called **cross-pollination**.

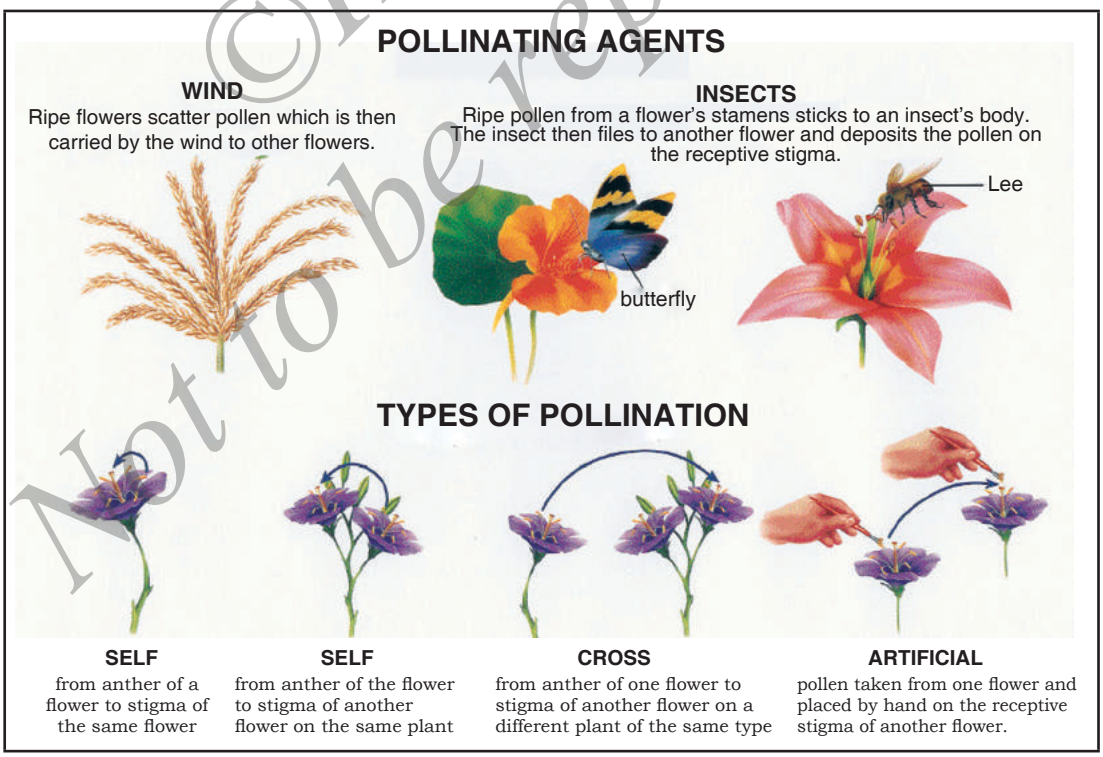


Fig. No. 20.3(a) Pollinating agents (b) Types of Pollination

Activity 20.2

Visit a near by park to observe the role of honeybees, butterflies, other insects and birds in pollination.

Flowers that are pollinated by wind are generally small and dull coloured. They produce large number of dry and light pollen grains. Sugarcane, maize and grass are common examples of wind pollinated plants.

> ***Find out:*** In nature cross pollination is more common than self pollination. Why ?

In aquatic plants generally, we see the formation of separate male and female flowers. Male flowers detach from the plant, float on the surface. The female flowers remain attached to the plant. Male flowers are carried towards the female flowers by water current where they release pollen grains. **Valisneria**, **Hydrilla** and **Elodea** are common examples.

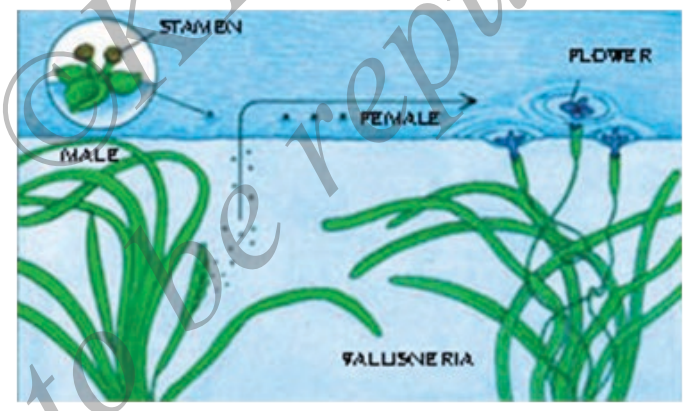


Fig. 20.4 Pollination in Vallisneria(Tape Grass)

Plants pollinated by insects show certain modifications in flowers to attract insects. These modifications are mainly concerned with the colour of the petals. Some flowers contain glands called **nectaries** which produce nectar to attract insects that bring about cross pollination. Flowers which open during night, usually have a dull colouration, but have an aromatic smell to attract insects.

Apart from insects, another group of animals that visit the flowers are the birds. Several kinds of smaller birds visit the flowers for the nectar and in the process, bring about cross pollination. There are also instances of flowers that are pollinated by bats and even snails.

Fig. 20.5 Pollination by animals

Fig. 20.6 Pollination by bat and butterfly

2. Fertilization : It is the secod major event during sexual reproduction.

The process which follows pollination is called **fertilization**. It involves the fusion of the haploid male gamete in the pollen grain with the haploid female gamete in the ovule.

Observe the figure 20.7

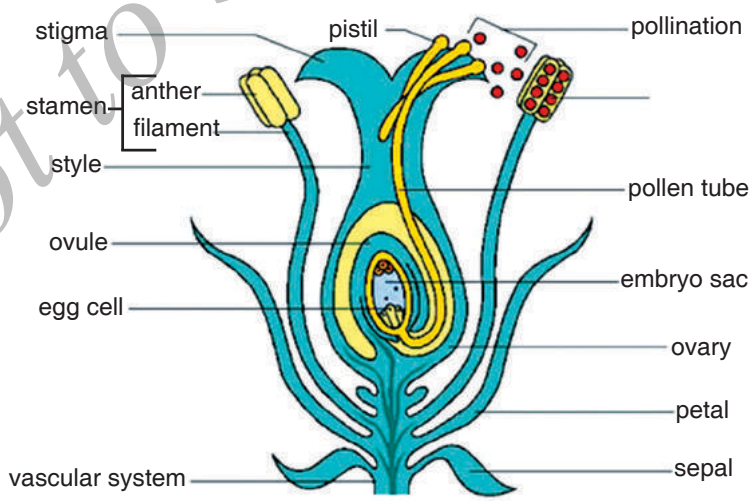


Fig. 20.7 Fertilization

To bring about fertilization, the pollen grains which get deposited on the stigma of the carpel must penetrate the style and reach the ovule. Hence, each pollen grain produces a projection called **pollen tube** which grows through the length of the style and finally reaches the ovule. The pollen tube enters the ovule and delivers the male gamete.

Activity 20.3

Take two cavity slides. Pour a few drops of water into one slide and a few drops of 2% sucrose solution into another. Shake a slit open anther from a hibiscus flower into each of these slides. Keep the two slides in a safe place for about 4 hours. Later examine the slides under a microscope. What do you notice?

The pollen grains in the slide containing sucrose solution show the formation of the pollen tube. What is your inference?

Inside the ovule, there is a structure called **embryo sac** which encloses the female gamete. Then male gamete and female gamete unite. resulting in the formation of a **zygote.** This process is called **fertilization.**

3. Development: Formation of embryo, seed and fruit

Development of zygote into a young plant is the third and final event in sexual reproduction. Various steps involved are -

- The zygote develops into an embryo that later differentiates into a seed and grows into a new plant.
- Surrounding the embryo, a nutritive tissue called **endosperm** is formed.
- The ovule becomes the seed.
- The coverings of the ovule transform into the seed coat.
- Ovary portion of the carpel gets transformed into the fruit enclosing the seed.
- Petals, sepals and other parts of the flower fall off .

You are aware of the fact that the variety of vegetables that we use as food are the different parts of angiosperm plants. It may be in the form of leaf, stem, root, fruit or seed.

Activity 20.4

- *Make a list of the vegetables that are used for making food in your house.*

Classify them into leaves, stems, roots, fruits and seeds.

The seeds we use as a part of staple food are generally distinguished into pulses, grains and millets.

Fig. 20.8 a) Pulses **b) Grains** **c) Millets**

- **Pulses** are the principal source of proteins. Our country is the largest producer and consumer of pulses. They are primarily seeds occurring in variable sizes and colours inside a type of fruit called **pod**. All of them belong to the pea family- Leguminosae.

  Example : Blackgram, green pea, lentil, cow pea and green gram.

- **Grains** are small, hard dry seeds with or without the fruitwall attached. Most of the grains are generaly described as cereals. They are produced primarily by varieties of grasses belonging to the family **Poaeceae**. Ex- Maize, rice, wheat, barley, oat and sorghum

- **Millets** are coarse grains where the protein content is said to be higher. Ex- Jowar, bajra (pearl millet) and ragi. The seeds are much smaller than grains.

Know this : Maize, rice, wheat, barley, oat and sorghum are the grains that account for more than 85% of the total grain production in the world.

You have learnt

- The importance of reproduction in plants.
- The diagram of a typical flower.
- Structure and functions of the parts of a flower.
- The role of insects and birds in plant reproduction.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer:

1. Seed develops from

   a. ovary b. ovule c. embryo d. embryo sac.

2. Colour of night blooming flowers is usually

   a. violet b. red c. yellow d. whitish.

3. The correct sequence of reproductive stages seen in flowering plants is

   a. gametes, zygote, embryo, seedling

   b. zygote, gametes, embryo, seedling

   c. seedling, embryo, zygote, gametes

   d. gametes, embryo, zygote, seedling

4. The anther contains

   a. ovules b. female gametes. c. ovary d. pollen grains.

II. Fill in the blanks with suitable words :

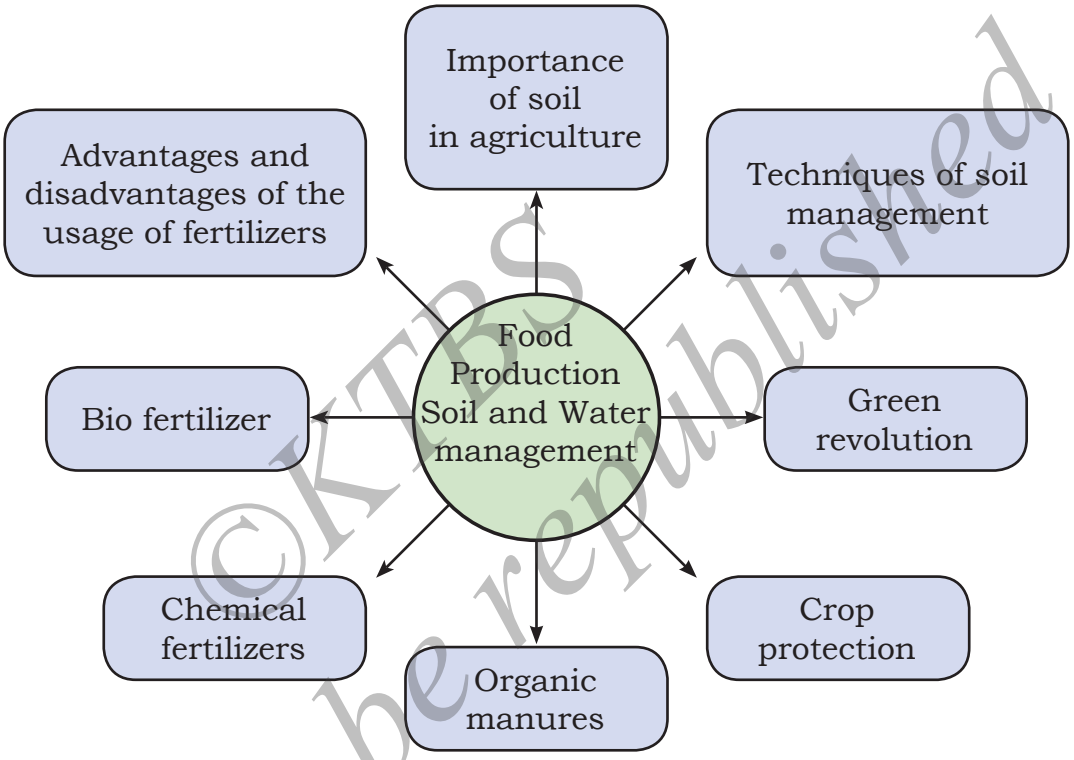
1. Flowers with blue petals, nectar and strong scent are most likely pollinated by _____ .
2. Variations in the offspring is the characteristic of _____ reproduction.
3. There is much wastage of pollen grains in _____ pollination.
4. Fertilization leads to the formation of _____ .

III. Answer the following :

1. What is reproduction?
2. What is sexual reproduction?
3. What is pollination?
4. Are insects friends of farmers? Explain.
5. Draw the diagram of a typical flower and label the parts.

CHAPTER 21

FOOD PRODUCTION : SOIL AND WATER MANAGEMENT



We have studied many things about food and nutrients. Should we not know from where we get our food? As you know, we procure food from two main sources - plant sources and animal sources

Without agriculture, the world cannot survive. Everyone depends on the farmers for their food. That is why we call them **'annadathas'.**

Agriculture is the art of cultivating crops and raising livestock. Many materials such as cotton and wool come from plants and animals raised in farms respectively. Agriculture remains the most important occupation in the world. Scientific methods and machinery have made farming increasingly productive. The development of improved plant varieties and fertilizers has helped to improve the yield of some major crops. Scientific care of livestock and breeding have helped to increase

the amount of meat and products that animals produce. At the same time, the use of tractors and other modern farm equipments have sharply reduced the need for farm labour.

For getting the best out of agriculture, the farming community needs

- Good seeds
- Availability of fertile land
- Water and irrigation facilities
- Manures and fertilizers
- Supportive social and economic environment
- Crop pricing policy
- Good prices for their produce
- Science and technology

Can you think of any other factors?. Discuss with your friends and teachers.

Agriculture is still the largest occupation in India, engaging a large section of our population. The success of our nation, our economy depends critically on the quality and effective output of agriculture. Several factors influence agriculture. Agriculture is a highly complex but a very important enterprise. Hence, it is important for us to realize the vast dimensions, problems and achievements in the field of agriculture.

Importance of soil in agriculture

What is soil? Soil is the top layer of earth made up of inorganic and organic materials. Generally it is fertile and supports various types of living organisms. The composition of these will vary from place to place. Soil plays a major role in all human activities. In fact, all of us get our living directly or indirectly from the soil. So does every other living organism.

Soil is an asset that we can hand over intact to countless generations. Crops take up their requirements such as water and minerals from the soil. Soil also provides anchorage for crops. It is the **primary nutrient reservoir** for plants. Thus, agriculture highlights the role of soil in the production of food.

Need for soil management

Soil is one of the major factors that affects food production. Crop plants need nutrients for their living, healthy growth and higher yield. Crops well fed with nutrients are likely to grow fast, remain strong and therefore show resistance to diseases. Soil that has higher capacity to supply the required nutrients is **fertile soil**. The productivity and performance of soil depend on several factors. They include soil fertility, water supply, land-slope, depth to the water table, climate and cultivation.

Think :

Can we grow crops without using soil? Human ingenuity has made it possible. A technology that enables growth of certain crops without soil is available. It involves growing plants with their roots in nutrient solutions and without soil. This is known as **hydroponics** (soilless cultivation).

A plant is a kind of biological factory. It requires a large number of raw materials. These include carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, magnesium, calcium, iron, manganese, zinc, copper, boron and many others. Plants get carbon, nitrogen, hydrogen and oxygen from air and water. Most of the other nutrients required only in smaller quantities are present in the soil. The problem is with the availability of nitrogen, phosphorus and potassium. Lack of one or more of these in the soil limits crop production.

Techniques of soil management

Soil management concerns all operations, practices and treatments used to protect soil and its fertility. Intense and prolonged agriculture in a given land causes a fall in land productivity.

Major techniques in soil management

- Control erosion of top soil.
- Maintain the water balance and regulate soil temperature.
- Improve the soil structure and maintain a stock of organic matter.

Know this :

Soil erosion is a process in which the top layer of the soil is removed by natural agencies like wind and water. In some cases even agriculture can lead to soil erosion and the net result is depletion of nutrients in the soil.

Activity 21.1

Collect information about soil erosion and make notes on the causes of soil erosion and ways of preventing it. Exchange the information with your friends. What type of agricultural practices will reduce soil erosion? What are the other problems that arise from soil erosion? Is there a loss of nutrients in your home garden or school garden? What measures do you suggest to prevent this?

Measures to maintain the soil nutrients.

Proper use of land

We can reduce nutrient loss from the soil by using the land only for those crops for which it is best suited. It is better to maintain a permanent green cover on lands such as steep slopes that are particularly vulnerable to erosion.

Rotation of crops

Rotation of crops is one of the oldest and effective methods for maintaining soil productivity. Many farmers grow different crops - monocot and dicot, one after another, in a regular sequence. This is better for the soil than growing the same crop, season after season. In rotation of crops, the crop for a new season is from a different family than the previous one. For example we may grow paddy or ragi in one season followed by a legume crop like groundnut, in the other season.

Think :

Is the practice of crop rotation suitable for a country like India where grain needs are high?

Rotation of crops also helps to keep the insect-pest population under check. Generally, insect pests and disease-causing organisms are host-specific. For example, rice stem borer feeds mostly on rice. If you do not rotate Paddy with other crops belonging to a different family, the pest population increases because food is always available. However, if you plant legume as the next crop, the insect pest is likely to die due to non-availability of food.

How does rotation of crops help to prevent the loss of nutrients? Rotation of crops gives higher protection against soil erosion. Crops that grow closely together greatly help in preventing soil erosion. Some plants

grow roots into deeper layers of soil while some spread horizontally. Rotating such crops enhances soil binding and fertility.

Find out :

Where do *Rhizobium bacteria* live? How does *Rhizobium* help to maintain the fertility of the soil?

Mixed cropping and multiple cropping

In mixed cropping, farmers sow one main crop and one or two subsidiary crops together on the same land. Mixed cropping technique can be followed both in dry and wet lands. In this technique, crops utilize soil nutrients more efficiently. There is no extensive use of any single nutrient. This also provides some kind of security for the farming community against crop failure. Another advantage is that it secures the family requirements of cereals, pulses, oil seeds and fodder simultaneously.

There is limited land available for agriculture. Hence, we must find ways of increasing the yield per hectare. One way is to go for multiple cropping. We must grow more than one crop in a year or season. This requires good irrigation facilities and short duration breeds. We, in India, have attempted multiple cropping by introducing such crops as barley, potatoes and vegetables in addition to crops like paddy, maize, jowar and bajra.

Find out :

Differentiate between mixed cropping and multiple cropping

Keeping the land unused

Some farmers replenish soil fertility by keeping the land unused for a season or two. They allow animals such as sheep, goats to graze. Their droppings will enrich the soil.

Role of organic manures in soil management

Organic matter in the soil consists of fresh organic matter and humus. Humus is formed by the decay of organic matter. Humus in soil improves the soil structure, resists soil erosion, retains water and enriches the nutrients.

Organic manures bind loose soil, increase their water holding capacity, help in aeration, assist in penetration of roots, add plant nutrients, also increase microbial activity that are helpful for crops.

Think : Many farming families use cattle dung to make cakes. They use these cakes as fuel for cooking and heating water. What are the disadvantages of this practice?

Preparation of compost

How can we make manure from organic matter? The natural decomposition process converts complex organic matter into manure. We can however regulate and speed up this process. First, we collect and stack up the organic material in a heap inside a pit or vessel. The decomposition is more intense in a heap. This is because the conditions for decomposition are more favourable. The product is **compost**, which is nothing but well-decayed organic matter with humus and nutrients.

Activity 21.2

You can make compost in a small place around your house or school or even in a bucket or a plastic bag. Dig a pit. Put any organic waste such as vegetable peels, cowdung, fallen leaves from trees, crop residues or even weeds into the pit. Cut them into small pieces if they are too large. Put a layer of soil over them. Sprinkle water over the soil to keep the matter moist. Go on heaping layer after layer until the pit or the bag is full. Microbes break up the organic matter into simpler forms. Adding a few earthworms will also help. Leave it for 8-10 weeks. Compost is now ready for use.

We must add organic manures in relatively large quantities. We must add them before sowing or planting of saplings. Why is it not so useful to add organic manures in the middle of the cropping season? What options do the farmers have?

Biofertilizers

Sometimes farmers add living microorganisms like *Rhizobium, Azotobacter, Azolla, Nitrobacter* and *Phosphotika* to the soil. Adding such organisms increases soil fertility and promotes plant growth. These organisms add up nutrients by their activity and help to build up the fertility of soil and safeguard the quality of crop products.

Types of Biofertilizer	Category / microorganisms	Useful for Crops
1.Nitrogen Biofertilizer	Free living- Azotobacter, Nostoc. Symbiotic- Rhizobium	Non legume crops. (Wheat, rice, Sugar cane) Legumes (Pulses, oil seeds)
2.Phosphorus Biofertilizers	Bacteria:- Phosphotika, Bacillus, Pseudomonas Fungi – Penicillium, Aspergillus	Used for any type of crops.
3.Compost Biofertilizer	Fungal culture, azotobacter culture	Many crops.
4.Plant growth promoting rhizobacteria (PGPR)	Pseudomonas	Many crops.

Know this : *For instance, organisms like Rhizobium, Azotobacter, Acetobacter, and blue-green algae help to mobilize nitrogen. A biofertilizer like Phosphotika mobilises phosphorus.*

Role of chemical fertilizers in soil management

Chemical fertilisers play an important role in crop production. They are synthetically prepared to include the vital nutrients essential for the plant growth. They contain the nutrients in specific ratios in a readily usable form. We can easily assess the requirement by soil testing. Farmers may choose, depending on the need, to use fertilizers that provide a single nutrient or mixed nutrients. For example, NPK has nitrogen, phosphorus and potassium. Monopotassium phosphate has high content of both phosphorus and potassium. Urea is a fertilizer which provides only one nutrient namely nitrogen. Chemical based fertilizers are cost-effective and can supply plants with proper balance of nitrogen, phosphorus and potash.

Problems of chemical fertilizers

The chemical fertilizers add several salts to the soil which alter the soil characteristics and cause pollution of land. This destroys the soil fauna. They affect the aquatic organisms also.

Alternate agricultural practices for soil conservation

Organic farming

Organic farming is a form of agriculture that relies on techniques such as crop rotation, green manure, compost and biological pest control, to maintain soil productivity and control pests in a farm. Organic farming strictly limits the use of chemical fertilizers and synthetic pesticides and medicines. Hence it is ecofriendly.

Water management

We all know that water is a critical input for agriculture. Our present practices of water use will lead to severe water crisis.

Production of food and other agricultural products take 70% of the freshwater from rivers and ground water. There is a serious competition for water for various human activities. Fig. 22.1 shows relative requirement of water for agriculture and domestic consumption.

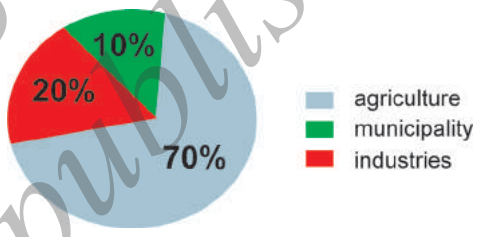


Fig. 21.1 Usage of water

Our environment is under threat from agricultural practices. What practices are harming the environment? The problem will get aggrevated and becomes unmanageable if we do not address the issue now.

Efficient management of water in agriculture

Efficient irrigation combines two factors: managing available water by using the right amount at the right time and installing and maintaining an energy-efficient irrigation system.

To improve the water management, one should first learn about crop and its root system. Efficient irrigation will just saturate the root zone and does not cause surface run off or allow water to percolate below the root zone

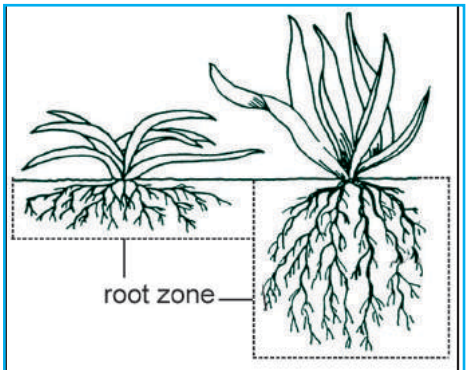


Fig. 21.2 Plants with different root zones.

Think : Observe the plants shown in figure 21.2. Which of the plants needs more water? Why do you think so?

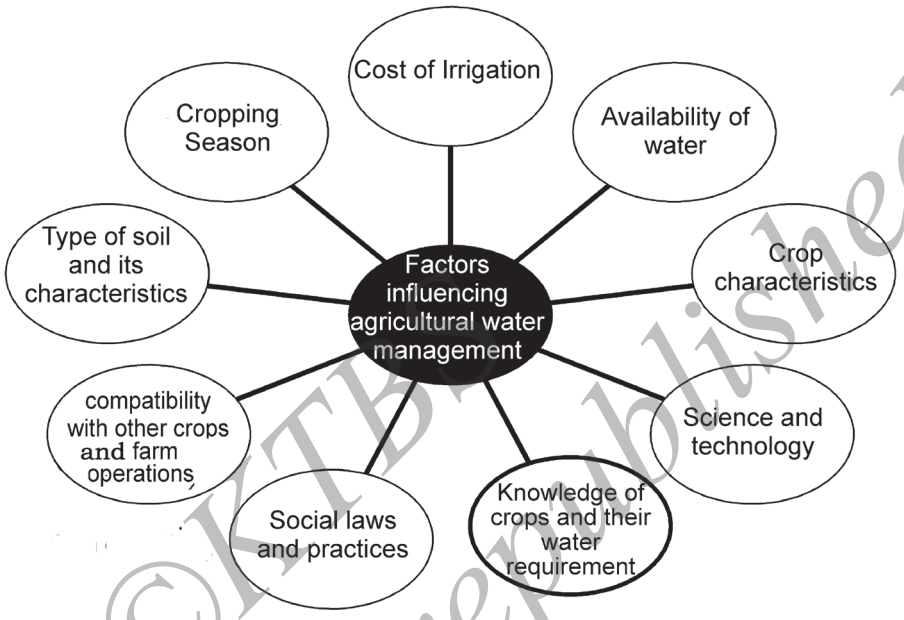


Fig. 21.3 Factors influencing agricultural water management

Efficient irrigation systems must maximize efficiency and minimize labour and capital requirements. The type of irrigation system farmers follow will vary from location to location, crop to crop, year to year and farmer to farmer.

Activity 21.3

Observe figure 21.3 carefully. It lists some important factors that influence the irrigational practices. Study them carefully. Give one example to show how each factor influences agricultural water management. Exchange ideas with your friends.

Common irrigation systems

i) Drip irrigation

ii) Sprinkler irrigation

iii) furrow irrigation

Activity 21.4

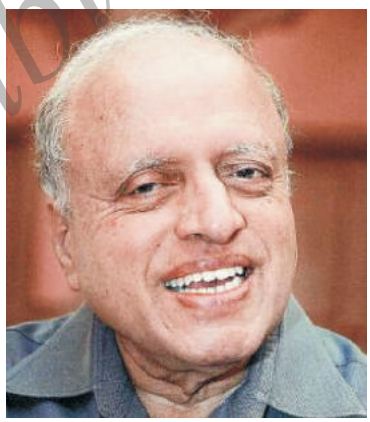
- Collect more information about the types of irrigation systems and crops grown adopting these systems.

Green Revolution in India

Green Revolution refers to the boom in agricultural production that resulted from the introduction of high-yielding varieties of seeds, increased use of fertilizers and introduction of improved irrigational practices. William Gaud coined this phrase in 1968. It involved the development of high-yielding varieties of cereal grains, expansion of irrigation infrastructure, and distribution of hybrid seeds, synthetic fertilizers, and pesticides to farmers. The impact of green revolution in India was more impressive on the production of wheat and rice.

Architect of green revolution in India: Dr M.S.Swaminathan

Dr M.S.Swaminathan, Indian agricultural scientist, is called the **father of green revolution in India.** Swaminathan set in motion fundamental changes in agricultural production in India that have put an end to India's age-old status as a nation on the brink of starvation. He is an outstanding scientist and researcher. He has served many agencies and organizations as an advisor, policy maker and above all as a great leader. He made relentless efforts to find sustainable ways to achieve peoples' basic right to food. Many nations have honoured him with national and international awards and several honorary doctorates. He is a Fellow of the Royal Society of UK and of the National Academy of Sciences of US.



Dr M.S. Swaminathan

Know this : Several rulers in India gave priority for agriculture. The sages probably had convinced the rulers that prosperous agriculture is the foundation for strong empires. The tradition had been to impose minimal tax on farmers. We find examples of this in Ramayana and Mahabharata. Rama asks his brother Bharata in Chitrakoot, "Dear Bharata, have you ensured that all those engaged in agriculture and animal husbandry receive your special care and attention?" In Mahabharata, Bhishma advises King Yudhishtira in "Shantiparva": "Agriculture, animal husbandry and trade are the very life of people.

Agriculture in ancient India

Agriculture is no new vocation for Indians. According to archaeological findings, paddy was a crop grown along the banks of the Ganga in the sixth millennium BC.

Rigveda mentions about productive and non-productive soils. The Amarkosha describes 12 types of lands in its chapter on **Bhumivargaha**. Fertility and physical characteristics were the basis for this classification.

Ancient Indians appreciated the importance of manures in obtaining high crop yields. **Krishiparashara** states that crops grown without manure will not give yield. It also describes a method of preparing manure from cowdung. Kautilya mentions the use of cowdung, animal bones, fish, and milk as manure. **Agnipurana** recommends application of 'excreta of sheep and goat' to increase flowering and fruiting of trees. In **Bruhat Samhita**, Varahamihira recommends the use of sesame plants as green manure. Surapala (1000 AD) describes the ancient practice of preparing liquid manure called kunapa.

Rigveda mentions irrigation of crops by river water through channels as well as irrigation from wells. Buddhist literature provides evidence of building small tanks for irrigation.

People in southern India had developed extensive tank irrigation systems during the first two centuries of the Common Era. Availability of irrigation made it possible to extend cultivation of rice to large areas and thus improve food security.

You have learnt

- The importance of management of soil.
- The various practices in vogue for rational management of soil.
- Brief description of each of the various practices followed for enrichment and maintenance of the soil.
- The advantages and disadvantages of organic manures and chemical fertilizers.
- The types of nutrients added to the soil by the use of various types of chemical fertilizers.
- Description of some environment friendly farming methods.
- The contribution of Indians to the field of agriculture.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements/questions. Choose the right answer:

1. **Rhizobium** bacteria are associated with the fixation of

   a. oxygen b. carbon dioxide

   c. nitrogen d. water vapour.

2. Green plants, normally do not suffer from the deficiency of

   a. phosphorus b. sulphur

   c. iron d. carbon

3. One of the arguments against too much use of chemical fertilizers is that, they

   a. decrease the taste of the food b. reduce the nutrients in food

   c. affect soil bacteria d. consume too much water

4. One of the advantages of growing chilli plants between two rows of green gram plants is that

   a. chilli plants are protected by the shade of dhal plants

   b. nitrogenous fertiliser prepared by green gram plants can be utilised by chilli plants

   c. chilli plants get water from green gram plants

   d. dhal plants are protected from pests in the presence of chilli plants

II. Fill in the blanks with suitable words:

1. Father of green revolution in India is _____.
2. NPK fertiliser has the elements nitrogen, phosphorus and _____.
3. Urea which is a chemical fertiliser is a rich source of _____.
4. By using animal dung and organic waste we can make an organic manure called _____.

III. Match the following :

A	B
1. deep rooted plants	a. do not need nitrogenous fertiliser
2. plants that are not deep rooted	b. always need rain water
3. plant roots containing rhizobium	c. need chemical fertilisers
4. loss of water	d. occasional watering
	e. frequent watering
	f. furrow irrigation
	g. need nitrogenous fertiliser

IV. Answer the following :

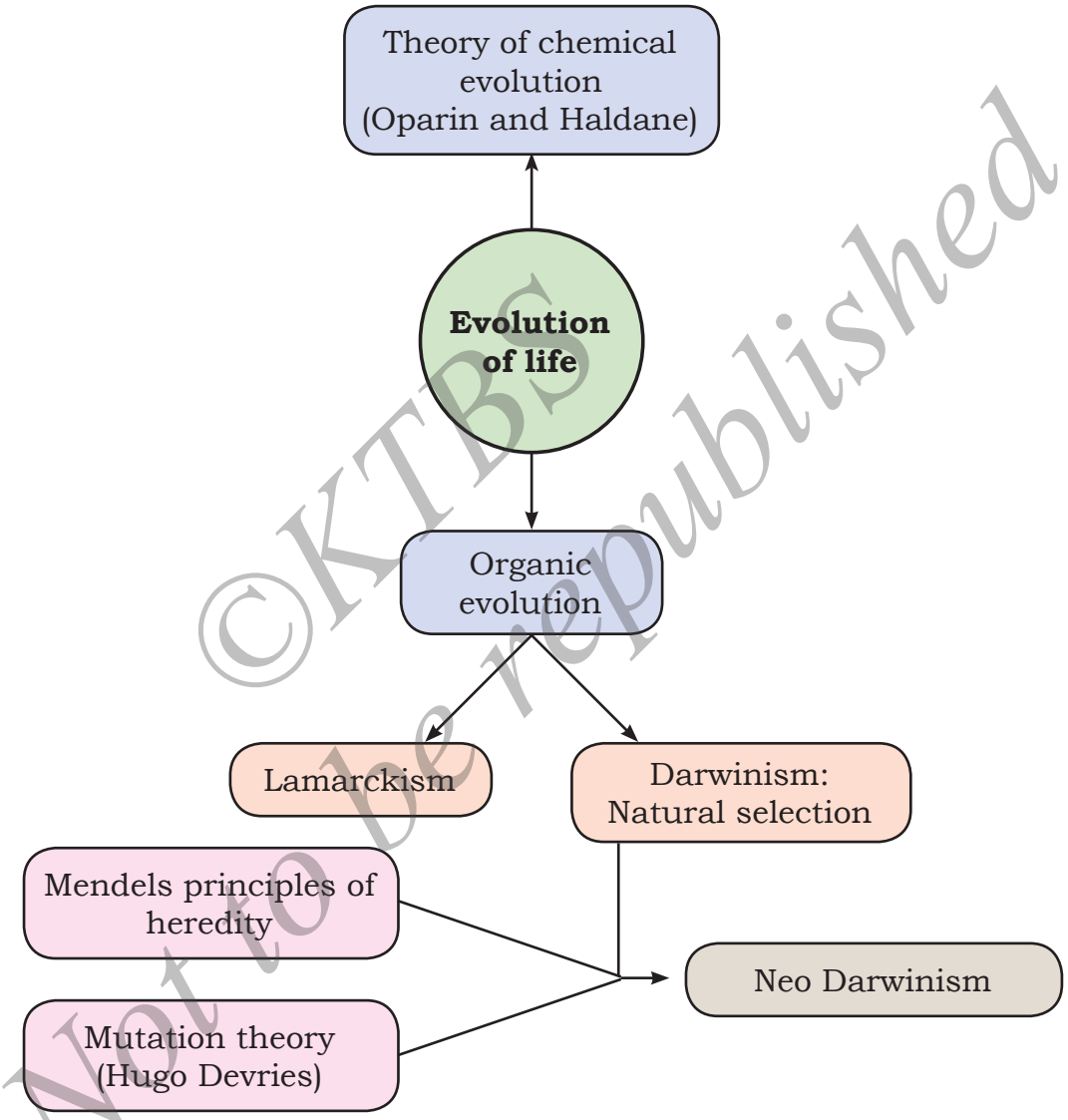
1. List any two advantages and two disadvantages of using chemical fertilizers.
2. Why should farmers enhance the amount of humus in their farmland? How do they do that?
3. Distinguish between organic manures and chemical fertilizers.
4. List some agricultural practices that help to maintain the fertility of soil.
5. How do you prepare compost manure?
6. List any three ways by which soil erosion occurs. State any two measures to reduce the loss of top soil.
7. What are the advantages of organic farming ?
8. Suggest measures to conserve water in agriculture.

Think

1. What is your view on organic farming? If you were to have a piece of agricultural land, do you opt for chemical farming or organic farming? Give reasons for your choice.
2. How can we ensure food security for all people of our country?
3. Why should we find ways for conserving water used in agriculture? What are your suggestions for the conservation of water?
4. How can we make agriculture more eco-friendly?

CHAPTER 22

EVOLUTION OF LIFE



You are familiar with the idea that a large number and variety of living organisms are existing on this earth. What is the reason behind this variety? Were they present right from the time of origin of earth? Earth was formed about 4.6 billion years ago and the first form of life appeared only about 3.8 billion years ago.

What changes must have occurred on earth leading to the formation of life? What changes must have occurred in living organisms to make them more and more complex? Let us try to find answers to such interesting questions in this chapter.

Origin of Life:

When the earth was formed about 4.6 billion years ago, it was a hot revolving ball of gas. The extremely high temperature and the dry climate of the earliest earth would have made it impossible for life to appear and exist. It is now fairly clear as to what it means to be 'alive' or 'living'. However, it is not clear as to 'how life first originated'. With the pieces of evidence available, scientists have traced the possible chain of events which might have taken place on earth in the past 1 to 4 billion years.

You will recall that it was Louis Pasteur who conducted the famous **swan necked flask** experiments. With this he proved beyond doubt that all forms of life arise only from pre existing life. However, one question still remained unanswered. How did the first form of life appear on Earth? The answer to this question came in the form of a theory, called **theory of chemical evolution**. This theory was proposed by Oparin and Haldane independently.

The theory assumes that :-

- the earth's surface and atmosphere during the first billion years of its existence were radically different from those of todays conditions.
- the primitive earth's atmosphere did not have oxygen.
- the first life arose from a series of chemical reactions.
- solar radiation, ultra violet rays and lightning must have been the chief sources of energy for these chemical reactions.

Fig. 22.1 Early Earth

In the initial days of earth's formation, heavy elements such as iron and nickel were present in the centre of the earth . Comparatively lighter ones like aluminium and silicon formed the crust. Elements like hydrogen, oxygen and carbon were found in the outermost layer. Due to high temperature, the atoms of these elements could not combine to form molecules. As the earth started cooling gradually, the atoms started combining to form molecules.

As cooling of the earth continued for thousands of years, the atoms of different elements combined together at random. This led to the formation of molecules. The earliest molecules formed were those of hydrogen (H_2), nitrogen (N_2), ammonia (NH_3), methane (CH_4), carbon dioxide (CO_2) and water vapour (H_2O). These compounds formed the basic molecules for the origin of life. Even molecular oxygen (O_2) is found to have been formed much earlier. But it probably combined with other elements like carbon, hydrogen, aluminium, iron to form their respective oxides. Hence, it is thought that the early atmosphere did not contain molecular oxygen.

It is assumed that water vapour condensed and formed clouds which then resulted in continuous rainfall for hundreds of years. The rain water is said to have filled the hollows and basins on the surface of the earth to form oceans. With further cooling of the earth, the **inorganic molecules** combined with one another to form simple **organic compounds.** Simple sugars, fatty acids, glycerol, aminoacids and nitrogen bases were presumed to have been formed at this stage. These changes took place in the presence of energy provided by discharge of electrical charges due to lightning and ultraviolet rays.

As the earth cooled further, these simple organic compounds combined among themselves to form complex compounds. Haldane suggested that due to the accumulation of the complex organic molecules, the sea water ultimately became a sort of a ***hot dilute soup.*** In this soup, molecules interacted and aggregated to form more complex molecules called **coacervates**. Due to their affinity towards water molecules, an envelope of water molecules is said to have formed around each of them. This might have increased the chances of chemical reactions.

Gradually breaking down and building up of chemical substances started. The coacervates continued to constantly take in new materials from the ocean and release the degraded materials. Thus, they exhibited the basic properties of life such as **metabolism**, **growth** and **reproduction.** Gradually, a group of complex organic compounds,

including nucleic acids are said to have taken precise control of the **coacervates**. This led to the establishment of nucleic acids as the genetic material. In course of time, the coacervates became established into the first living systems which have been named **protobionts.** Some of the proteins in the protobionts are said to have developed the ability to speed up the chemical reactions, thereby functioning as the first **enzymes**.

Know this :

Coacervate: It is a colloidal particle like structure. It was formed during chemical evolution of life. It was the first to exhibit the properties of life, 'growth' and 'reproduction'.

In the course of time protobionts became enclosed in a protein lipid membrane. This property improved their survival ability. Metabolism, growth and reproduction became regular, precise and controlled, leading to the formation of **first cells**.

The first forms of life developed in the oxygen-free atmosphere. Hence, it is believed that these primitive forms of life obtained energy by the fermentation of organic compounds. Recall anaerobic respiration, which you have read in chapter 20. They were, heterotrophs.

Activity 22.1

Write the changes from the primitive earth till the formation of first cells. Follow the example and fill in the blanks.

Formation of light and heavy molecules

↓

Combination of atoms to form molecules

↓

_____

↓

Hot dilute soup

↓

_____

↓

Protobionts

↓

_____

Autotrophs are said to have arisen much later in the primitive earth. The appearance of autotrophs in the form of **blue green algae**, changed the situation on earth. These organisms released free molecular oxygen into the atmosphere, gradually transforming it into **an oxidizing type**.

The following table summarises the sequence of events on earth leading to the appearance of life.

Table 22.1 Events on earth leading to the appearance of life.

Changes in time	4.6 billion years ago	3.8 billion Years ago	2.5 billion Years ago	Present
Radiation	High uv	moderate uv light	Less uv light	very low level of uv light
Constitiuents of Atmosphere	---	H_2,CH_4, H_2O, NH_3, CO_2, N_2	NH_3, H_2O, H_2, CO_2, N_2	O_3,O_2,CO_2, H_2O,H_2,N_2
Molecules	---	Simple Molecules	Complex Molecules	Organic molecules Produced by cells
Cell/Life forms	None	None	Protobionts	Present day forms

Organic Evolution

The primitive cells that resulted from chemical evolution, gradually gave rise to organisms such as bacteria, algae, fungi and protozoans. These organisms in turn, gave rise to a variety of life forms that are existing today on earth. This was possible due to the slow and gradual process by which living organisms have undergone changes from the single celled forms to many celled forms of life.

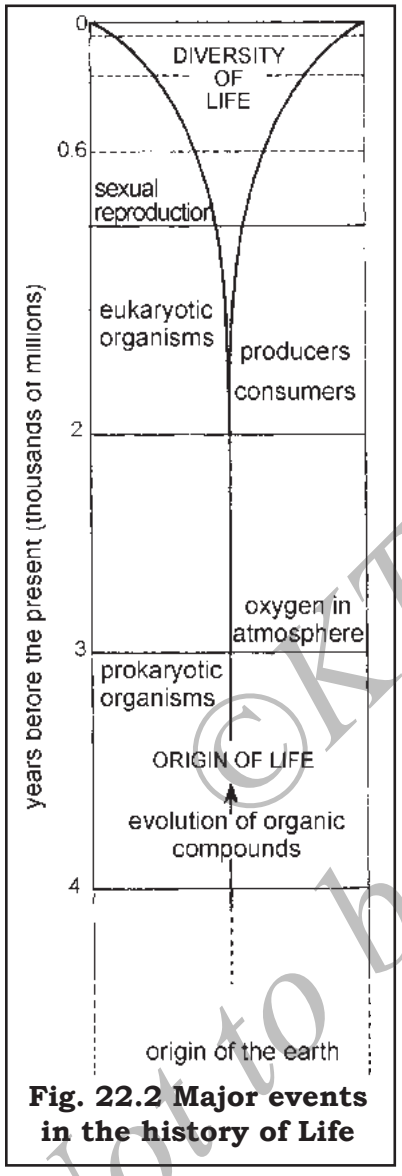


Fig. 22.2 Major events in the history of Life

This slow and gradual process of change through which the present day complex forms of life have descended from simple forms of the past is known as **organic evolution.** The process is the result of innumerable modifications which the organisms have developed under the influence of their environment. These changes have been passed on from generation to generation bringing about formation of new varieties within and across species. Here, organic evolution is termed 'Descent through modification'

The occurrence of evolution is supported by innumerable direct and indirect evidences. The mechanism of organic evolution has been explained by ideas put forth by scientists from time to time. These ideas came to be known as **theories in organic evolution.** Following are some of the theories that tried to explain the mechanism of organic evolution.

Lamarckism

One of the earliest ideas on organic evolution was proposed by a French Zoologist **Jean Baptiste Lamarck**. In 1809, he proposed The **Theory of inheritance of acquired characters**. It is also described as **Lamarckism.** The theory is based on three main ideas **new needs, use and disuse of organs** and **inheritance of acquired characters.**

- Environment is highly unstable and is subject to frequent changes. Lamarck believed that such changes create new needs in the organisms. If the organisms fail to make necessary changes favourably, they cannot survive.

- The appearance of new needs forces an organism to put in additional efforts to fulfill the needs. It may put particular part of its body into more and more frequent use. Similarly it may also be necessary for the organism to put a part of its body into less use or may not use it at all. This idea came to be known as **use and disuse of organs.** Any part of the body that is more and more used, is likely to grow larger and become better and stronger. In the same way any part of the body which is less frequently used, has a tendency to become less prominent and may even ultimately disappear. Thus, by a differential overuse and disuse of various body parts, an organism would change to some extent and acquire new characters.
- Lamarck believed that characters acquired by an organism get transmitted to the future generations. In every generation, new characters are acquired. As a result, after many generations the changes accumulate and the species becomes modified into a new one.
- Lamarck's ideas on evolution may be explained by citing a few examples from his own writings.The example of giraffe is cited in support of the idea of overuse of body parts. Among mammals, you know that giraffe is peculiar in having a long neck and long limbs, Lamarck, suggested that the ancestors of giraffe were as small as deer. Due to severe competition from other herbivores and drought the availability of grass and other small plants depleted. Lamarck suggested that giraffe started stretching its neck and fore limbs in order to reach the leaves of taller plants. This continued for several generations and as a result, neck and limbs became longer.

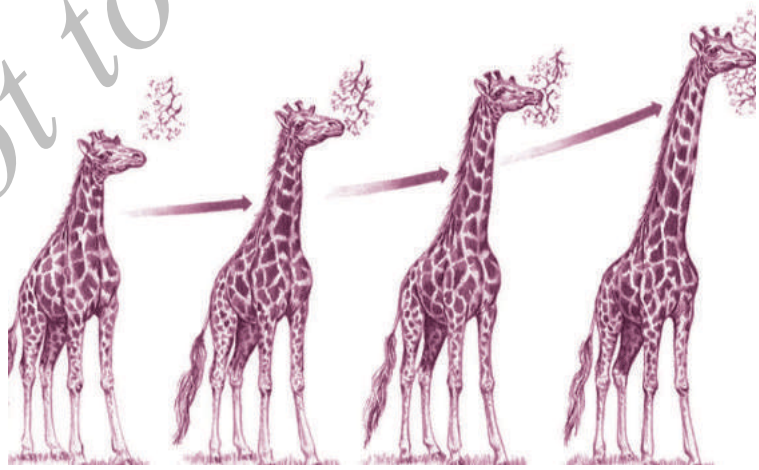


Fig. 22.3 Lamarck's theory of use and disuse of parts

The absence of limbs in snakes was interpreted by Lamarck as an evolutionary change. He suggested that ancestors of snakes had four well developed limbs. Snakes were hunted by more advanced group of animals such as birds and mammals. In order to survive, they started spending most of their time hiding in crevices and holes. Thus, they started disusing their limbs. This resulted in the limbs becoming degenerate and ultimately disappear. The limbless condition was passed on to subsequent generations.

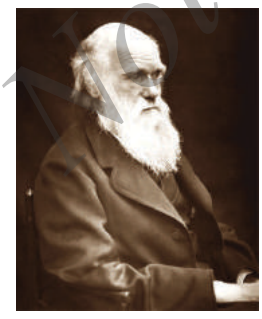
Activity 22.2

Collect information in support of use and disuse theory of Lamarck

Lamarck's ideas had some drawbacks. His theory can not explain how body cells pass on the acquired characteristics to reproductive cells. Experiments have shown that acquired characters are not inherited.

Weismann's experiment

August weismann conducted a simple experiment called mutilation experiment on rats. He cut off the tails of a male rat and a female rat. According to Lamarck, the taillessness is an acquired character and is heritable. To verify this, Weismann allowed these tailless rats to breed. Surprisingly, the offsprings were normal tailed. Not satisfied with this, Weismann went on repeating the procedure for 21 generations and each time, he got normal tailed rats. Based on these results, he disproved Lanmarck's theory of inheritance of acquired characters.



Charles Darwin

Darwinism

Charles Darwin proposed a theory in 1858 to explain the possible mechanism of evolution. This theory is known as **theory of natural selection** or more popularly as *'Darwinism'*. This theory is based on the following normal principles.

Principles of Darwinism

Activity 22.3

Take a small pot with soil. Sow about 25-30 bean seeds. Sprinkle water over the soil. Observe the changes daily for a week.

- *How many seeds have germinated ?*
- *Are they similar in height, size and other aspects ? why ? What is your inference ?*

- Darwin found that generally the young ones of an organism show differences compared to the parent. He described the differences as **variations.** They help an organism to adjust better to the environment.
- Darwin found an interesting feature in all organisms. All organisms have a natural capacity to produce a large number of young ones. He called this capacity as **overproduction**. Darwin gave many examples to support this idea.

Elephants are the slowest reproducing animals. In a life span of about 90 years, a pair of elephants may produce a maximum of six young ones. Darwin calculated that if all the six young ones survive, grow and reproduce at the same rate, there would be 19 million elephants in just about 750 years. In spite of such an enormous rate of reproduction the number of individuals in each species remains nearly constant over long periods of time.

- Darwin reasoned that, as a result of high rate of reproduction, there must be a competition between individuals. It is for sharing food, water, living space and other resources. This competition was described by Darwin as **struggle for existence.**
- Darwin presumed that only those organisms which have developed advantageous variations have a better chance of survival. The less adapted and the not adapted organisms get eliminated. This idea came to be known as **survival of the fittest.**
- Darwin believed that nature selects only those organisms which have favourable variations. They continue to produce young ones with these variations. This provides advantages to such organisms. Darwin described this process as **natural selection.**

Thus new species develop from the existing ones in a slow and gradual way.

Darwin believed that variations are the **raw materials** for evolution and natural selection is the **operating force**. However, Darwin failed to recongnize the source of variations in the organisms. Hence goes the common saying, *Darwin explained the survival of fittest, but not their arrival.* He had no idea of the mechanism of inheritance.

Victor Hugo Devries in 1902 proposed the idea that variations are brought about by sudden changes in the genetic make up of an organism. Such changes are called **mutations**. The modern theory on organic evolution is the synthesis of ideas from the **theory of natural selection, the mutation theory and Mendel's principles of heredity.** It is known as **Neodarwinism**.

You will be studying about Mendel's principles of heredity in higher classes.

You have learnt

- Changes that have occurred on earth during origin of life.
- Atmosphere of ancient and present earth.
- Importance of organic evolution.
- Theories of organic evolution.

EXERCISES

I. Four Alternatives are given to each of the following incomplete statement / question. Choose the right answer

1. The phrase 'hot dilute soup', was used by

   a. Oparin b. Darwin c. Haldane d. Pasteur

2. Which gas was absent in the atmosphere at the time of origin of life?

   a. ammonia b. hydrogen c. oxygen d. methane

3. The first organisms on primitive earth were

   a. autotrophic b. heterotrophic and anaerobic

   c. parasitic d. prokaryotic and autotrophic

4. The greatest weakness in Darwin's theory was his failure to explain

a. over production
b. survival of the fittest
c. struggle for existence
d. variations

II. Fill in the blanks with suitable words :

1. Earth was a hot revolving ball of_____ about 4.6 billions of years ago.
2. Lightest element hydrogen was found in the _____ layer of the earliest earth.
3. Variations caused by sudden genetic changes are called _____.
4. Darwin explained the survival of the fittest, but not their_____.

III. Match the following :

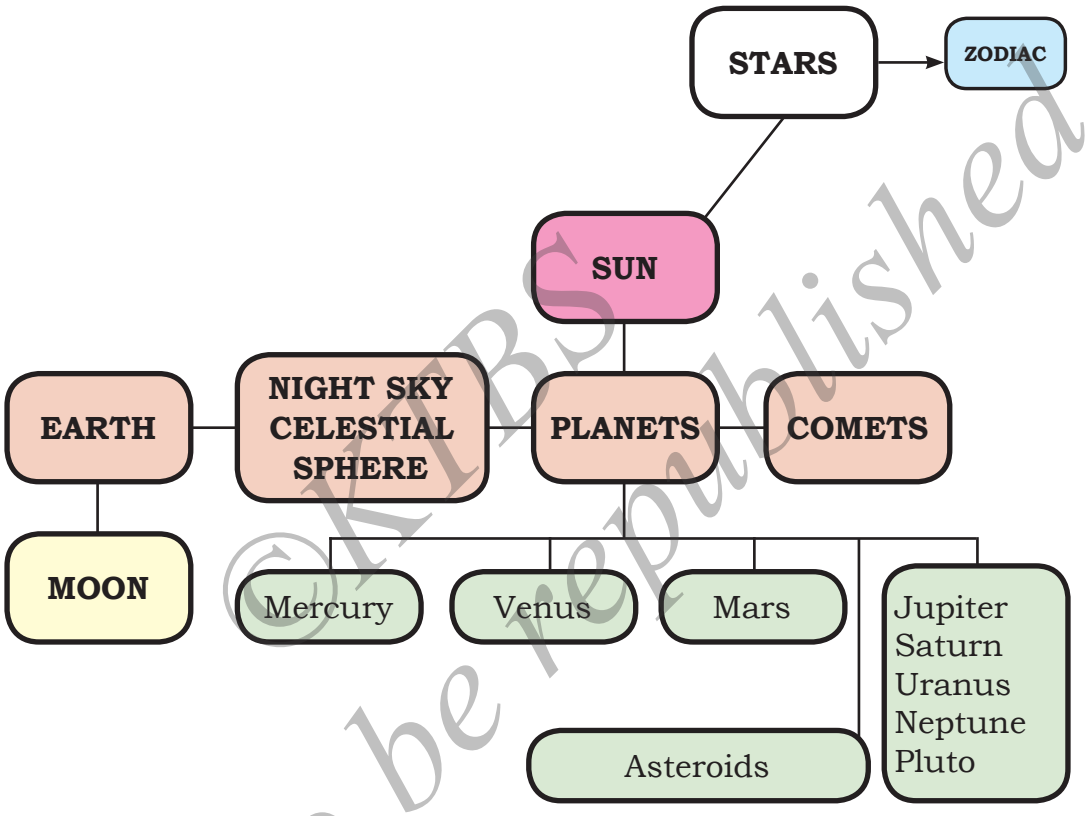
A	B
1. Lamarck	a. neodarwinism
2. Darwin	b. mutation theory
3. Hugo Devries	c. theory of natural selection
4. Oparin	d. theory of inheritance of acquired characters
	e. theory of chemical evolution

IV. Answer the following :

1. What is organic evolution?
2. Explain Lamarck's theory of use and disuse of organs with suitable examples.
3. What is the role of variations in evolution ?
4. What is mutation ?
5. Define Neodarwinism.
6. Which organisims changed earth's atmosphere from reducing to oxidising type ?
7. What were the limitations found in Darwinism and Lamarckism ?

CHAPTER 23

EARTH AND BEYOND



WHAT WE KNOW ABOUT EARTH

Let us recall the facts we have learnt about earth in earlier classes.

1. Earth is almost spherical in shape. It's diameter is about 12000 km
2. Earth rotates on its axis. Because of this, half of the earth is lighted by the sun and the other half is in darkness. Areas facing the sun experience day time. Areas facing away from the sun experience night. The north pole and south pole have continuous daylight or darkness depending on the time of year.
3. The axis around which earth spins is an imaginary line through the center of the planet from the north pole to the south pole. Earth's axis is tilted at an angle of 23.5 degrees with the orbital axis. Earth has seasons because its axis is tilted. The result is warm (summer)

weather in the Northern Hemisphere and cold (winter) weather in the Southern Hemisphere. The rotation of the earth around its axis was first noted by Aryabhata, an Indian scholar of 6th century AD.

4. Earth is considered as a planet. It is the fifth-largest planet in the solar system and is the third-closest planet to the sun. Only Mercury and Venus are closer.

5. Like all planets, earth orbits the sun once every 365 days, or one year. It's average distance is 150 million km from the sun. That distance is termed one Astronomical Unit (AU). However, the shape of its orbit is not quite a perfect circle. It's more like an oval, which causes earth's systems from the sun to vary during the year.

6. Below earth's surface are layers of rock and metal. Temperature increase with depth, all the way to about 12,000 degrees Fahrenheit at earth's inner core.

7. Earth consist of land, air, water and life. The land contains Mountains, valleys and flat areas. The air is made up of different gases, Mainly nitrogen and oxygen. The water includes oceans, lakes, rivers, streams, rain, snow and ice. Life consists of people, animals and plants.

8. Earth is studied using artificial satellites which look at earth from space. They take pictures of, and collect information about, all earth's parts. From space, earth looks like a blue marble with white swirls and areas of brown, yellow, green and white. The blue is water, the white swirls are clouds. The areas of brown, yellow and green are land. And the areas of white are ice and snow volcanoes and their smoke.

9. Artificial satellites help scientists predict weather and climate. It also helps public health officials track diseases and famine. It helps farmers decide when to plant crops and what kinds to plant. And it helps emergency workers respond to natural disasters.

THE NIGHT SKY

Have you observed the night sky on a cloudless day? You will really enjoy watching it. The patterns in the sky have inspired many design makers and poets too. Clear moonless night in a place far away from the city is best for watching the sky. Even otherwise, it is a good experience to watch it.

Fig. 23.1 Night Sky

You might have noticed moon and hundreds of twinkling stars in the night sky. They are distributed all over the sky. You see many recognizable patterns of stars. If you observe carefully you may also see star-like objects which do not twinkle. Occasionally you may see streaks of light which give the impression of falling stars.

PLANETS

Objects which shine but do not twinkle are planets. Their paths are not uniform. Because of their seemingly wandering motion they were called wanderers. Stars twinkle but planets do not. They are in general brighter than most stars. You will also learn in higher classes that stars are self luminous but planets are not. Size of a star compared to planets is large. They appear small because of their enormous distance from the earth. Only four planets are visible to the naked eye. They are Venus, Mars, Jupiter and Saturn. You may be able to observe another planet Mercury just before sunrise or just after sunset if the sky is clear.

THE CELESTIAL SPHERE

Any shining object in the night appears to be located on a huge sphere. We appear to be at the center of the sphere. This imaginary sphere is called celestial sphere. What could be the radius of such a sphere? Objects on the celestial sphere are called celestial objects. Direct observations show that most of the celestial objects appear to move from east to west. This observation made many people think that we are at the center of the universe and all celestial objects move round us.

Based on the above observation people developed a model. The earth was considered as the center of the universe and all other celestial objects moving around us. The model is called 'Geocentric' model'. Greek scholars like Aristotle, Ptolemy and others believed in this system. The Geocentric model was not able to explain the changing brightness and the variation in the path of planets.

Nicholas Copernicus proposed an alternative model called 'Heliocentric' model'. He placed the Sun at the center of the observable universe around which other celestial objects including the earth would revolve. This explained the movements of the planets better than the 'Geocentric' model. Later Galileo Galilee provided scientific evidence for this model by his observations with the telescope. And Johannes Kepler showed that paths of the planets around the sun are elliptical.

Indian Astronomer Neelakanta Somayaji based on a suggestion of his teacher "Parameshwara 'had proposed a model similar to the 'Heliocentric' model. Development of the telescope and mathematical calculation based on gravitational laws by Isaac Newton helped to get a better understanding of the movement of planets around the sun.

THE SOLAR SYSTEM

Let us learn about Heliocentric model. Solar system is a very small part of the entire universe.

It has one star that is "sun" at the centre and planets and other objects moving around it. Solar system, as we understand today, consists of the following:

1. The Sun is at the centre of the solar system.
2. Apart from the planets which are visible to the naked eye namely Mercury, Venus, Mars, Jupiter and Saturn-, there are two more- Uranus and Neptune – which can be seen by a telescope.

3. The Asteroid belt between the orbits of Mars and Jupiter
4. Dwarf Planets like Pluto, Ceres, Eris and others
5. Satellites of the planets which are also called the moons of the planets
6. Comets such as Halley
7. Artificial objects like satellites and spacecrafts

SUN

Sun is the center of the solar system. It has a radius which is 109 times that of the earth. This means it would take 13 lakh earths to fill the Sun. It consists mainly of hydrogen and helium. The reaction in the sun releases enormous amount of energy. A part of energy is received by the earth in the form of heat and light. Life on earth is sustained by this energy. You will study more about sun in higher classes.

We shall study about the members of the solar system in the order of their distance from the sun.

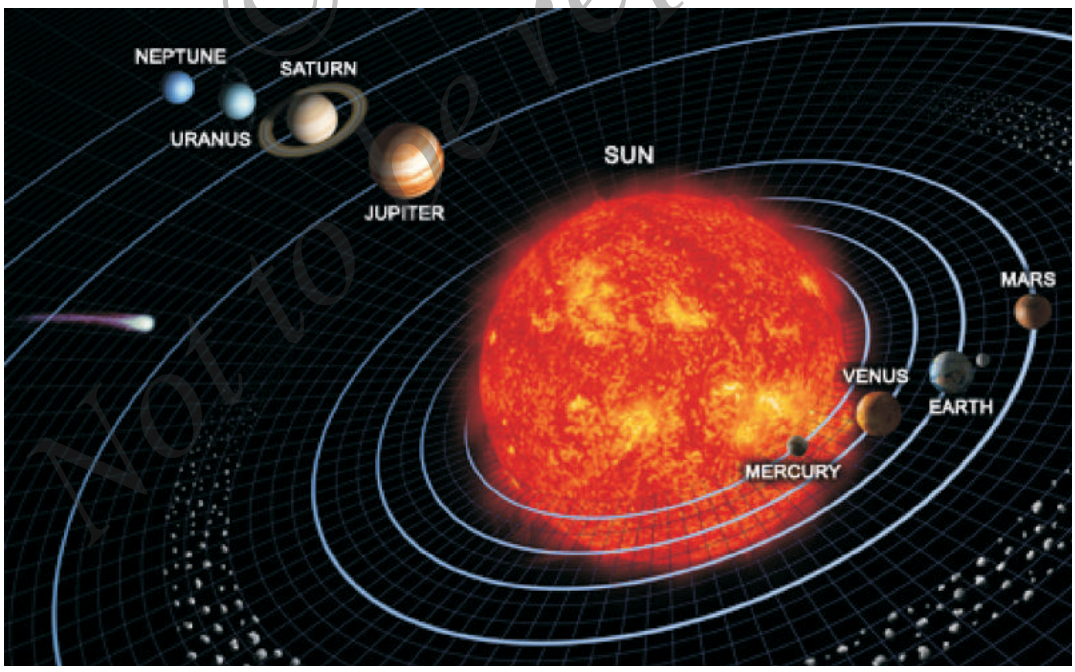


Fig. 23.2 Planets in our solar system

Mercury

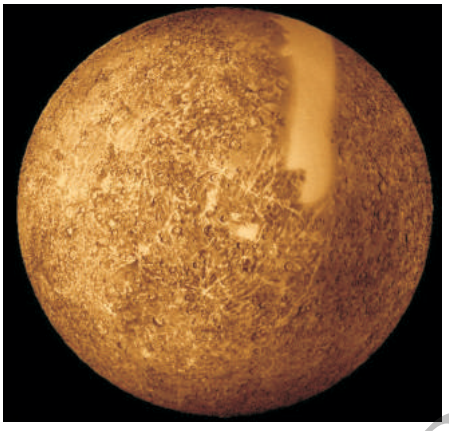


Fig. 23.3 Mercury

Mercury is the nearest planet to the sun. Sun rises or sets within about two hours of Mercury's rising or setting. You can spot it at the place of sunrise or sunset, early in the morning or soon after sunset. But it is difficult to get a good view. Mercury has heavily cratered surface (see fig.24.3) Surface temperature varies from 427 ^{0}C to -183 ^{0}C. Its period of rotation and period of revolution are 59 days and 88 days respectively, its density is 5.43gcm^{-3}.

Venus

Venus is the second planet. It can be recognized easily. Its atmosphere is made up of mostly carbon dioxide. Sunrise and Sunset as seen from the planet will be in the west and east direction respectively. Can you give reason for this?. Its period of rotation is 243 days and takes 225 days to go around the sun once. It means a day on Venus is longer than its year.

Fig. 23.4 Venus

What is the duration of day and year on earth? Compare the speed of rotation of Earth and speed of rotation of Venus. What is your conclusion?

The surface temperature of Venus should be less than that of Mercury considering its distance from the Sun. But it is comparable to Mercury. It is about 450 ^{0}C. This is due to the greenhouse effect or warming in common language. Carbon dioxide blocks long wavelength Infrared radiations and heat is trapped inside. The density of Venus is 5.2 gcm^{-3}.

Activity 23.1

Observe the sky at around sunset. In the western direction above the horizon you will notice a bright shining celestial object. It is the first object that you can see in the western sky before the cover of darkness. It is Venus. Sometimes you can see it in eastern sky much before sunrise. People call it morning star or evening star though it is a planet.

Earth

Earth is the third planet from the Sun. Earth has one known natural satellite, the Moon. Earth is the only planet in the solar system on which life is known to exist. What makes earth so special? Which factors help life to originate, evolve and develop ? Several conditions are necessary for this. Can you list them?

Think : Is there any kind of life existing on any other celestial body? Attempts are being made to find an answer to this question. One such programme is SETI: SEARCH for EXTRA TERRESTRIAL INTELLIGENCE.

Nearly two thirds of the earth's surface is covered with water. Earth has an atmosphere which extends to a height of a few hundreds of kilometres, though we can not exactly define its boundary. The layers of atmosphere contain nitrogen, oxygen, carbon dioxide, water vapour and small quantities of other gases. Earth's density is $5.51 gcm^{-3}$.

Moon

When we talk about the moon many times we become poetic. Many songs and many poems have been written in the past inspired by different phases of moon. It appears as a big bright celestial body during full moon day which arouses curiosity. You might have seen it many times during the day time also. It is the only known natural satellite of the Earth. There are huge craters on the moon. It has no atmosphere. India explored the moon in its programme called "Chandrayan I" in 2009. Earlier America had undertaken a historic mission in which American astronaut Neil Armstrong landed on the Moon. He was followed by Edwin Aldrin.

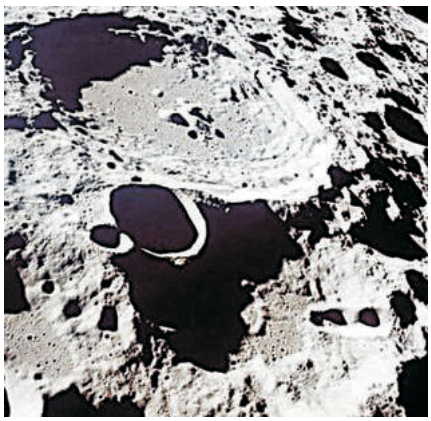


Fig. 23.5 Craters on Moon

Fig. 23.6 Apollo, the spaceship in which man went to moon

How did the two astronauts talk to each other when there is no air for sound to travel? How did they get oxygen ?

Recall : Draw pictures of different phases of moon which you have studied in the earlier classes.

Mars

Mars is the fourth planet . It is a reddish planet. Spacecrafts like Viking have explored Mars, for evidence of life.

Some places on Mars have moderate temperature. Mars has oxygen, nitrogen and water. It has frozen carbon dioxide near the poles which looks like ice caps. It is the presence of these factors that made us to think about the existence of some form of life on Mars. Mars has two natural satellites Phobos and Deimos. The density of Mars is $3.2 g/cm^3$. The average surface temperature varies from - 60^0 C to +25^0 C. Period of rotation of mars is about $24\frac{1}{2}$ hours. Its period of revolution is 687 days.

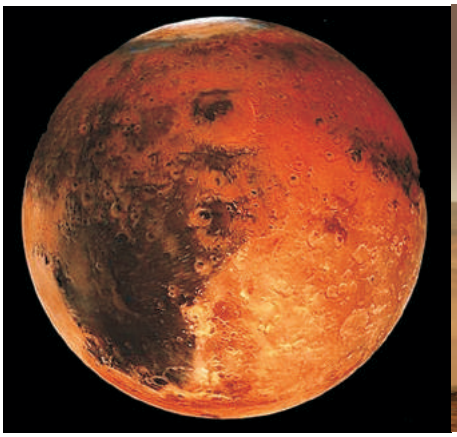


Fig. 23.7 Mars

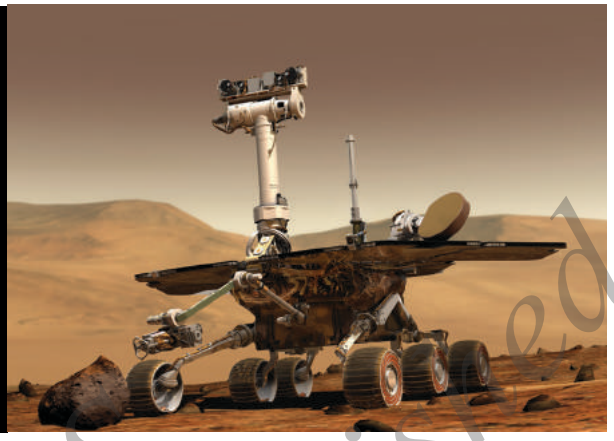


Fig. 23.8 Rover on Mars

Asteroids and Meteoroids

Between the vast space of the orbits of Mars and Jupiter, there are thousands of irregular shaped lumps of rocks that orbit the Sun. They are asteroids. Some asteroids are also found in other parts of the solar system. But the main asteroid belt is between the orbits of Mars and Jupiter. The large asteroids are Ceres, Pallas, Juno and Vesta.

Meteoroids are chunks of matter which may have originated from asteroid belt. Sometimes they may enter the earth's atmosphere and burn up due to the heat generated by friction. When the meteoroids burn in the atmosphere, they are called 'meteors' or shooting stars. They are also called falling stars. If a large number of them in the sky happen to appear at the same time, they cause a shower of meteors. During the passage of an asteroid or a comet some of their fragments burn up after entering the earth's atmosphere. Bigger meteoroids sometimes survive the journey and hit the earth resulting in craters and dents on the earth's crust. Such meteoroids are called meteorites. Many planets and satellites have large craters formed by the impact of meteorites.

Leonid showers

In the constellation Leo, you may observe large number of meteors, during the night of November 17th/18th. They are known as Leonids showers.

Jupiter

Fig. 23.9 Jupiter (Guru, Bruhaspathi)

Jupiter is the fifth planet. It is the largest planet of the solar system. Its orbital period is nearly 12 years. Its day is about 10 hours. That means it rotates very fast. Due to fast rotation it is bulged at the equator and flattened at the poles. The thick gas clouds which cover the planet due to its strong gravitational force also rotate with the planet resulting in bands and zones. These are visible through a telescope. Try to identify this planet in the night sky.

The density of Jupiter is 1.3g/cm^3. Jupiter is far away from the Sun. Can you imagine its surface temperature?

Galileo identified four satellites of Jupiter using a telescope built by himself. They are Io, Europa, Ganymede and Callisto. There are many other satellites of Jupiter. Io is an interesting satellite because it has active volcanoes. Voyager space craft discovered a ring system around the planet. Europa has the possibilities of some type of life. Jupiter emits radio signals.

Fig. 23.10 Jupiter and its four large satellites

Saturn

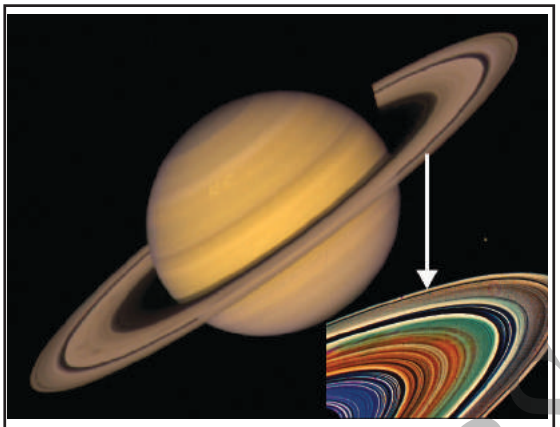


Fig 23.11 Saturn and its ringlets

Saturn is the sixth planet. It is the second largest planet in the solar system. It is a fascinating experience to view this planet using a telescope. Its special feature is a prominent ring system, which is made up of many small ringlets. The ringlets are made up of icy, rocky matter. Its specific gravity is less than that of water. It has many satellites of which Titan is of special interest. It is the only natural satellite which has its own atmosphere in the solar system. Saturn has density of 0.69g/cm^3. It has the lowest desity when compared to other planets. Its period of rotation and revolution are 10 hrs 40 minutes and 29.46 years respectively.

Uranus

Uranus is the seventh planet and it is the third largest planet. A ring system around this planet was discovered by Prof.J.C.Bhattacharya and K.Kuppuswamy of Indian Institute of Astrophysics, Bengaluru. The planet was first discovered by William Herschel. It is a peculiar planet because its axis of rotation has a tilt of about 82^0. Except Venus all the planets rotate from west to east with some tilt. Uranus has a density of 1.39g/cm^3. Its period of rotation and revolution are about 17 hours and 84 years respectively. This planet appears to rotate on a horizontal axis. Compare this to the tilt of the earth.

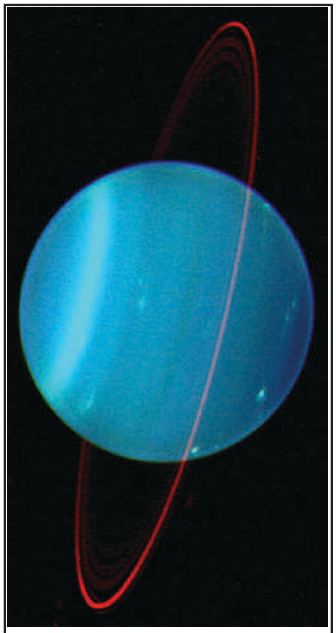


Fig. 23.12 Uranus

A globe will help you to compare the axis of rotation of Uranus with the axis of rotation of the earth.

Know this : You have seen the models of globes .You might have wondered why the model of the earth is inclined instead of being straight. What might be the reason? Can you imagine the model of Uranus ?

Neptune :

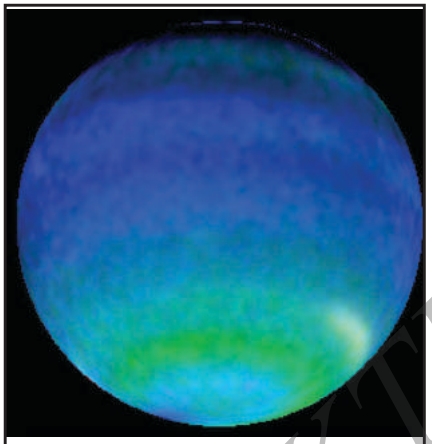


Fig. 23.13 Neptune

Neptune is the eighth planet from the Sun. The planet Neptune can be seen only with the help of a telescope. Earlier its existence was predicted by mathematical calculations. Its density is $1.6 g/cm^3$. Its period of rotation and revolution are 16 hrs 30 minutes and about 165 years respectively.

Pluto

Till 2006 Pluto was considered as a planet of the solar system. But in 2006 the International Astronomical Union (IAU) adopted a new definition for a planet and according to this Pluto does not qualify as a planet of the solar system. However it continues to be a member of the solar system. Now it is called dwarf planet.

Activity 23.2

Find out the reasons for removing Pluto from the list of planets.

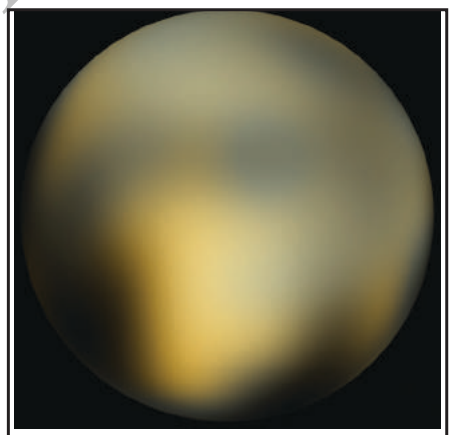


Fig. 23.14 Pluto

Comets

Comets are curious objects of the solar system. Comets have long orbital periods and appear rarely.

Major constituents of nucleus of a comet are silicates and matter made up of frozen gases and water.

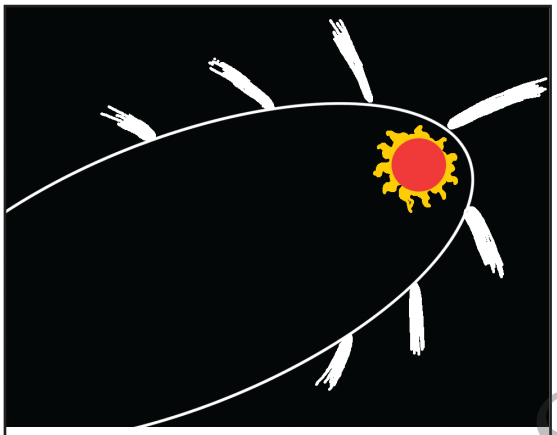


Fig. 23.15 Comet

Comets are irregular in shape. When they come near the Sun they develop tails. Why? They become visible when they are close to the sun and earth. Watching comets is a hobby for number of astronauts. Many comets are named after their discoverers. One such comet is Halley comet which can be seen once in 76 years. It was last seen in 1986. When is it likely to be seen next?

Activity 23.3

Collect information about different comets that have appeared in the past 60 to 70 years.

Superstitions about the Comets

Some people think that comets are messengers of disasters, such as wars, epidemics and floods. But these are all myths and superstitions. Appearance of a comet is a natural phenomenon. We have no reason to be afraid of it.

Can we add new members to solar system ? In addition to our natural satellite Moon, we have added thousands smaller moons in the form of artificial satellites which are revolving around the earth. Artificial satellites are useful to us in many ways. Can you list their uses?

Fig. 23.16 Artificial satellite

Stars

Apart from members of the solar system there are celestial objects which kindle our curiosity. Let us study about them. You see many twinkling celestial objects in the night sky. These are stars. They appear to be at the same distance. Why?

Sun is the nearest star to us. You know that light takes about 8.3 minutes to reach the earth from the Sun.

The light from the other stars of the night sky takes years to reach the earth. Imagine what might be their distance ! They must be quite huge. The distance of stars is usually expressed in terms of a unit called light year. One light year is the distance travelled by light in one year. This is equal to 365 × 24 × 60 × 60 × 300000 km. Consider the star Sirius. It is the brightest star in the night sky. It is about 8.7 light years from the earth. That means when you look at it, the light that enters your eye has left the star 8.7 years ago.

You observe stars of different colours. They have yellow, orange, white, red and blue colour. How are temperature and colour related?

Activity 23.4

Hold an iron wire with insulated handle and heat. First it becomes red. When heating is continued it turns into orange yellow and whitish in colour before it melts down.

Activity 23.5

Observe the blue flames of a LPG stove when it is being used. Also observe the change in colour of the blue flames when water drops get sprinkled on the flame. Can you give reason for change in colours?

Red, orange, yellow, white and blue colours indicate the increasing order of temperature of the stars.

Star patterns in the sky

When you look at the stars in the night sky you observe certain patterns. The patterns remain unchanged over a period of time. People imagined some objects, animals and mythological characters formed by joining the positions of stars. The region around the recognisable pattern of a group of stars is called a constellation. The sky is divided into 88 constellation regions. Each region is named after that constellation. For example, group of seven stars in the north is called Saptharshi Mandala or Big Bear or Ursa Major.

Ursa Major with seven stars appear to move around the pole star. You may see it in the early morning hours of winter season in Karnataka.

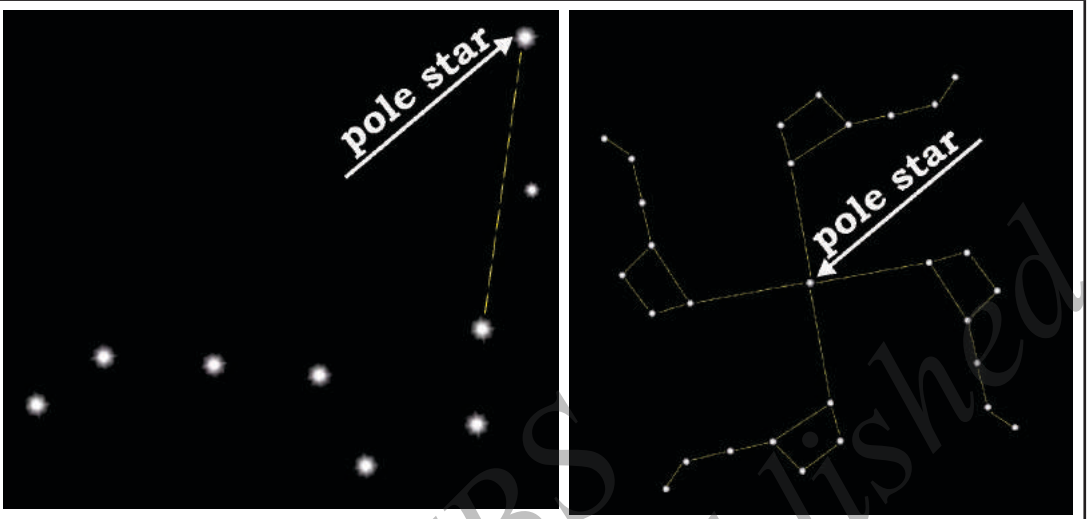


Fig. 23.17 Ursa major constellation with pole star at different times of the night

Note : Stars are seen as dots. The lines drawn are imaginary.

Constellation Cassiopeia in northern region of the sky can be used to locate the position of pole star during early night of winter season.

Know this : Apart from the usage of Mariners' compass there are different methods of finding the directions. One such method is locating pole star and also identifying the locations of Constellations. It also helps to know the approximate time, month. Some easily identifiable constellations are Ursa Major, Orion, Cassiopeia and Leo.

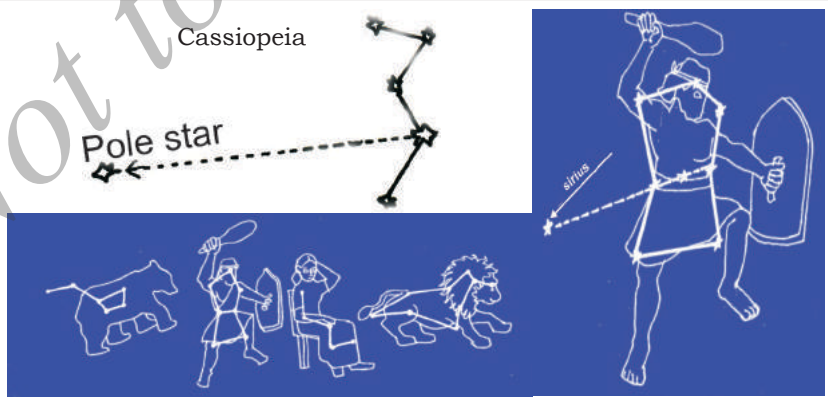


Fig. 23.18 A few constellations

Orion is the most easily recognized constellation in winter season. Its movement can be easily monitored. This constellation has a prominent red coloured star Betelgeuse. It also has a blue coloured star Rigel.

A straight line is drawn from the belt of the orion as shown in the figure (23.18) meets the star Sirius. Similarly an imaginary bisector of greater angle of the constellation Cassiopeia meets the pole star.

Zodiac

The movement of the Sun, the planets and the Moon appear to follow a path from east to west. This apparent path is called Zodiac belt. Twelve constellations which are located in this path are called Zodiacal constellations.

1. Aries (Mesha)
2. Taurus (Vrishabha)
3. Gemini (Mithuna)
4. Cancer (Karka)
5. Leo (Simha)
6. Virgo (Kanya)
7. Libra (Tula)
8. Scorpius (Vrischika)
9. Sagittarius (Dhanu)
10. Capricornus (Makara)
11. Aquarius (Kumbha)
12. Pisces (Meena)

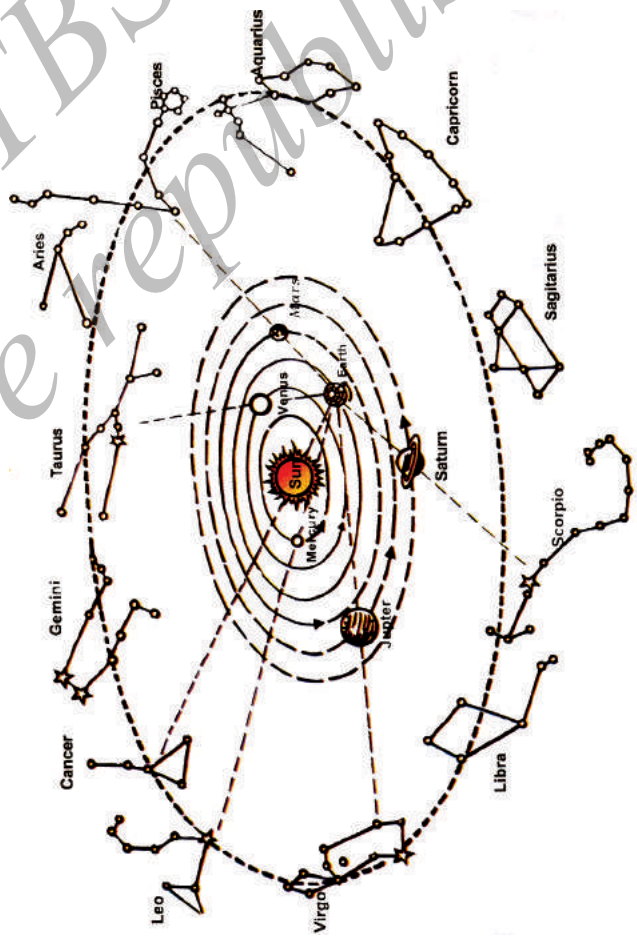


Fig. 23.19 12 Zodiacal constellations

Contrary to the popular belief of 12 zodiacal constellations, there is a 13th Zodiacal constellation. Its name is Ophiuchus. It is a large constellation located around celestial equator. Another name of this constellation is serpentarius meaning 'Serpent- bearer'.

You will study more about stars and galaxies in higher classes.

Extended Activity 23.6

Make your own planetarium and also visit a planetarium.

Take an opaque flat bottom plastic bowl. Paste white paper on the flat surface. Mark the constellation Ursa Major or Orion on it. With a sharp pin, pierce holes at the bottom of the plastic bowl on the stars of the constellation. A powerful lamp with diffused light (Filament lamps should not be used; otherwise pin hole camera effect will be found) like LED lamp should be placed inside. In a dark room project the holes on the roof of the room. You will see the constellation. If you use a bigger bowl with many constellations marked as holes you can rotate it and observe the movement.

You have learnt

- definition of the term celestial sphere.
- distinction between Geocentric and Heliocentric models of solar system.
- about the members of the solar system.
- about the main features of moon.
- to locate the planets Mercury, Mars, Venus, Jupiter and Saturn without the help of telescopes.
- distinction between stars and planets.
- about features of the planets.
- recognising familiar constellations.
- zodiacal constellations.
- about personalities associated with the study of celestial objects.

EXERCISES

I. Four alternatives are given to each of the following incomplete statements / questions. Choose the right answer :

I. The constellation that helps to locate north star is

a. Cassiopeia b. Orion c. Taurus d. Leo

2. The second biggest planet of the solar system has

a. lowest density b. density equal to water

c. highest density d. density equal to earth

3. The poles of this planet face the sun for longer periods of time than any other planet.

a. Mars b. Uranus c. Jupiter d. Saturn

4. Polar ice caps of the planet Mars are due to

a. Solidified water

b. Solidified carbon dioxide

c. Volcano eruption near the poles

d. Cover of dust particles that reflect light .

5. Heat waves are trapped to maximum extent in the planet

a. Mercury b. Venus c. Earth d. Neptune,

II. Fill in the blanks with suitable words

1. Radio signals are emitted by the planet _____.
2. The colour of the planet Mars is _____.
3. A Winter season constellation is _____.
4. Asteroids are mainly found between the orbits of _____.
5. Ultraviolet rays from the sun can be filtered by the earth's atmospheric layer called _____.

III. Match the following :

A	B
1. Highly tilted planet	a. Earth
2. Satellite of Jupiter	b. Titan
3. Constellation	c. Halley
4. Third Planet from the sun	d. Io
	e. Uranus
	f. Ursa Major
	g. Sirius

IV. Answer the following :

1. Which planet is called morning or evening star ?
2. Which planet was removed from the list of 9 planets in 2006 ?
3. Express the following in km
   a. 10 light minutes b. 10 light days c. 10 light years.
4. Name the following :
   a. Most fascinating planet with a set of ring system as viewed from a telescope
   b. Nearest planet to the earth c. Nearest planet to the sun
   d. Biggest planet of the solar system
5. How are satellites different from planets?
6. Which satellite has active volcanoes ?
7. Give reason for the following :
   a. A person in England can recognize the pole star easily than a person in Bengaluru.
   b. Mercury is difficult to observe
   c. A day on Venus is longer than its year
   d. Green house effect is prominent on Venus

V. State true or false :

1. Saturn has the highest density.
2. Venus can be seen overhead in the night sky.
3. Aries (Mesha) is a Zodiacal constellation.
4. Mars contains oxygen in its atmosphere.
5. Moon has no atmosphere.
6. Titan is a satellite of Jupiter.

SOLAR SYSTEM, A QUICK GLANCE

Sl. No.	Planets	Diameter	Year in Earth Time	Day in Earth Time	Main Gases in atmoshere	Number of Natural moons	Main features	Average distance of planets from sun in million km
1	Mercury	4878Km	88 days	59 days	Traces of Argon, Neon, Helium	0	Daytime temperatue 880^{0}F (470^0 C); night time -280^{0}F (-170^{0}C)	58
2	Venus	12102Km	224 days, 17 hrs	243days	Carbon diOxide(very thick)	0	Rotates east to west instead of west to east, as other planets do	107
3	Earth	12756Km	365 days, 6 hrs	(1 day)0 23 hours, 56 minutes	Nitrogen, Oxygen	1	Only body known to have life; mild climate, water as solid, liquid and gas	149
4	Mars	6792 Km	687 days,23 hrs	24 hours, 37 minutes	Carbon dioxide(thin)	2	Ice-caped poles, four seasons, dust storms	224
5	Jupiter	142984Km	11 years, 11 months	9 hours,56 minutes	Hydrogen, Helium	at least 60	Colourful bands of gas, marked by auroras near poles; Great Red Spot is a scar bigger than Earth	768
6	Saturn	120536Km	29 years, 5 months	10 hours, 39 minutes	Hydrogen, Helium	at least 60	Circled by colourful ice rings	1,424
7	Uranus	51118Km	84 years	17 hours, 14 minutes	Hydrogen, Helium, Methane	17	Tripped sideways	2,848
8	Neptune	49582Km	164years	16 hours, 7 minutes	Hydrogen, Helium, Methane	8	Winds of 1,500 kph (930 mph) recorded	4,480,000

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